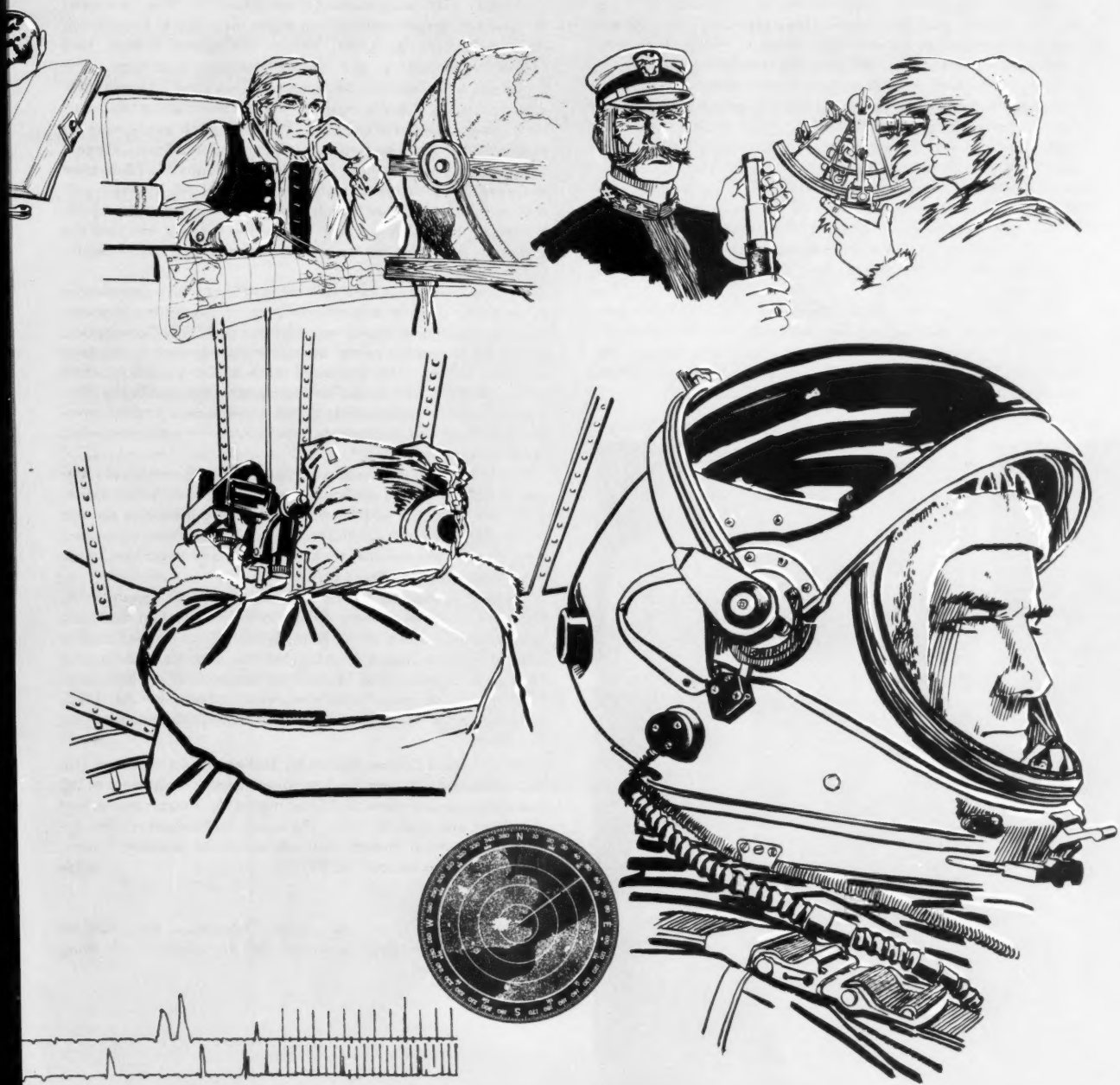
THE NAVIGATOR

AFRP 50-3, Volume XXII, Number 3, Fall 1975



NAV OF NOTE

Colonel Attilio Pedroli is the first navigator Deputy Commander for Operations in the history of the 323d Flying Training Wing at Mather AFB, California. His story is another example of excellent career progression, coupled with the opportunities afforded navigators since the amendment of Title 10.

He was born in Milford, Massachusetts, on 27 January 1931. He was raised in this small New England town attending public schools and graduating from Milford High School in 1948. He entered Northeastern University in 1948, majoring in chemistry with a minor in math, "...however, in 1950, with the Korean action going strong, I decided to try the flying game." He was called to report for Aviation Cadet training in early 1951, "...I ran into my first 'goof;' more personnel were called for training than the scheduled class size. I was one of the unlucky who was told to return home and await a new class assignment. As a result, I decided to enlist in the Air Force rather than sit and wait for the Air Force to call."

Colonel Pedroli completed basic training, basic electronic school, and advanced radar maintenance school, "...before the 'system' caught up with me." He entered Basic Observer Training in June 1952, some 15 months late.

Upon graduation from Basic Observer Training at Harlingen, Texas, he was assigned to the Advanced Radar Navigator program at Sheppard AFB, Texas. "I learned radar flying in the back end of a B-25 and in May 1953 I received my wings and was commissioned as a second lieutenant in the USAF."

His first assignment was to Randolph AFB, Texas, for B-29 combat crew training. This was followed by a year's flying in the B-29, "...when we could get them into the air. In the summer of 1954, we converted to the B-47 and I was on my way to Mather for upgrade training in the hope of returning to a B-47 outfit." However, upon graduation, he was assigned to the 11th Bomb Wing, Carswell AFB, Texas, and the home of the B-36. "Thus, I didn't get my B-47 assignment but did manage to leave Mather married—at the time, it seemed like a fair trade." Colonel Pedroli is married to the former Georga Crystal of Vacaville, California. They have six children—four boys and two girls. Some 1500 flying hours later, he returned to Mather for B-52 upgrade training and Castle AFB for crew training. He again reported to the 11th Bomb Wing, which had moved to Altus AFB, Oklahoma. Six years of crew duty on lead and select crews, and a two year stint in Standboard followed.

During this time, the squadron moved to Wright-Patterson AFB, Ohio, and became the 17th Bomb Wing, so "...I managed to squeeze in a TDY to Squadron Officer School." In 1964, he elected to "give up" a spot promotion to Major for a career broadening staff assignment as Chief, Target Intelligence Branch, and followed this with a tour as Maintenance Supervisor, 17th Armament and Electronic Squadron. "...Thus some 12 years after electronic school, I found myself in the electron chasing business." His attachment with the old 11th/17th Bomb Wing was terminated in August 1966 when he entered Air Command and Staff College.

Upon graduation in June 1967, he was assigned to EB-66 crew duty with the 355th Tactical Fighter Wing, Takhli AB, Thailand, with a short stop at Shaw AFB on the way to check out in the EB-66. While with the 355th, he flew 119 combat missions and held the Squadron Navigator slot for a short period of time before returning to the states.

"...Once again I returned to Mather AFB, but this time it was as an instructor and not as a student." He completed the Instructor Training School and after a very short stay as a Flight Commander, he moved to another career broadening assignment as the Base Executive Officer. "I then returned to the 3538th Squadron, which is now the 450th, as a Squadron Commander. This year in the 38th, working with an outstanding group of instructors and an ever-challenging group of students was one of the most rewarding years of my career."

In July 1971, he was reassigned to Stuttgart, Germany, as Commander of the 7005th Air Base Squadron. Colonel Pedroli was in command of a base with seven aircraft and a mission to provide airlift support aircraft for HQ USEUCOM. "In addition, I provided base support for several Army Aviation units and found I had more Army green than Air Force blue on base."

The call to join HQ USAFE at its new home at Ramstein AB, Germany, came in January 1973. "After a very short tour as a headquarters 'weenie' in the Radar Systems Shop, I moved back to base level as the Deputy Base Commander, 86th Combat Support Group." In October 1974, he assumed command of the 86th Combat Support Group and upon completion of his tour in July 1975, reported back to Mather AFB as Deputy Commander for Operations.

When I asked Colonel Pedroli his feelings about this new job, he commented, "Moving back to an operational assignment as DO is a challenge and more than I had hoped for. It again proves that the doors are opening wider and wider for Navigators. The opportunity to move through and into command positions is here. Now let's prove we can do it!"

Editor's Note: Since my initial interview with Colonel Pedroli, he has been elevated to the position of Wing Vice Commander.

THE NAVIGATOR

Volume XXII, Number 3, Fall 1975

UNITED STATES AIR FORCE

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Published tri-annually by Air Training Command with funds approved by Headquarters, United States Air Force. Distributed, in accordance with Air Force Manual 7-1, through the Air Force Publication Distribution Center on the basis of one copy for each two navigators.

Manuscript contributions are welcomed, as are comments and criticisms. Contact the Editor at the address below or at AUTOVON 828-2138 before extracting from or reprinting material. Opinions expressed by individual contributors do not necessarily reflect the official viewpoint of the Department of the Air Force.

Address manuscripts to Editor, THE NAVIGATOR Magazine, Bldg. 3875, Stop 21A (449 FTS), Mather AFB CA 95655. Address subscriptions to Superintendent of Documents, GPO, Washington DC 20402; yearly $3.00 domestic, $3.75 foreign; single copy $1.00. Air Force Recurring Periodical 50-3.

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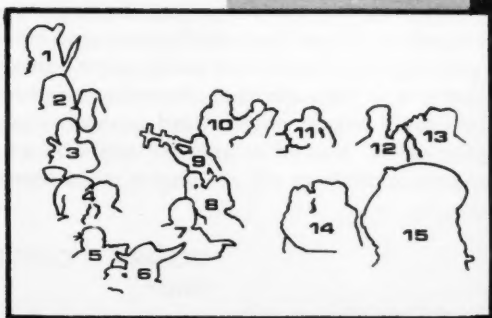

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MEET YOUR NEW EDITOR

CAPT RICHARD E. GORDON

By the time this issue has reached you, Captain Richard E. Gordon will have assumed the role as Editor of your magazine. Captain Gordon was born in Kansas City, KA, however, "... most of my formative years were spent in and around the various suburbs of Chicago." He attended Southern Illinois University, graduating with a degree in Psychology. "After graduation, I went directly to Officer Training School (OTS), received my commission in the summer of 1965 and reported to Mather AFB, CA, for navigator training." Captain Gordon graduated from UNT with Class 67-1 in July 1966. His first operational assignment was in C-130s flying from the island of Okinawa to all points in the Orient. "I spent most of that three-year tour refining my navigational skills, but I did receive invaluable writing experience as the Squadron Administrative Officer." In 1969, Captain Gordon left Okinawa and the C-130, transferring "stateside" to Travis AFB and the C-141. "Shortly after checking out in the aircraft, I was back in the administrative field and more valuable writing experience." His four-year tour at Travis saw him upgraded from Line Navigator to Flight Examiner. "I was the Assistant Chief of Navigator Standardization, 7th MAS, when the order came assigning me to Mather." Captain Gordon has been at Mather just under two years. He taught Grid and Overwater Navigation as well as the Career Planning blocks in UNT. Prior to his selection as Editor, he was a Flight Commander in the 452 FTS. Captain Gordon is married to the former Carole Peters of Homewood, IL. They have two children, Laura and Craig. Welcome aboard, Dick! I am positive THE NAVIGATOR is in good hands, and will continue as an outstanding Air Force publication.

CARL H. WELLS, JR., Major, USAF

FROM YOUR NEW EDITOR

I would like to say how pleased I am to be the new editor of THE NAVIGATOR. I've read this excellent magazine for many years and have been impressed with the professional way that it has kept the man in the field informed of everything from technical methodology to items of general interest. I shall endeavor to maintain the same quality publication. Each issue begins with a NAV OF NOTE, a navigator who has achieved a position of importance and authority. These men are splendid examples of career progression and an inspiration to all navigators. Title 10 has opened the door for the navigator. He can be competitive for positions which were closed to him in the past. These articles show you how it has been done, and how you might do it in the future with your heightened opportunities.

The magazine is composed of articles that you send to us for publication. Any subject pertaining to navigation is welcome, especially those you, the contributor, feel could benefit others. Send a personal photo and biography with the article so you can be recognized for your effort. Also let us know of any way we might improve the publication. This is your magazine, and with your participation we will continue to make it one of the finest in the Air Force.

RICHARD E. GORDON, Captain, USAF
Editor

A Professional Yesterday Today Tomorrow

Brigadier General Robert W. BAZLEY
Inspector General, USAFE

Editor's Note: As the commander of the Air Force's only Navigator Training Wing, Brigadier General Robert W. Bazley was frequently asked by many civilian organizations to discuss the mission of the 323d Flying Training Wing. Recently, on such an occasion, I was privileged to hear and would like to share with you, the General's comments.

"...It is interesting to note that the art of navigation far precedes the era of flight. The first recorded use of a navigation chart was in 1270 A.D., and the use of rudimentary celestial techniques preceded this by nearly a thousand years. The need for, and the contributions of, navigators is greatly attributable to the skills and daring of early navigators like Columbus and Magellan. It is also interesting to note that many of the basics of navigation, including the instruments and techniques, did not change significantly from the 18th Century until the early 1960s.

"In the last 15 years—and even more so during the last 10 years—we have seen the navigator career field, and the responsibilities and duties of navigators, expand to truly extraordinary proportions. Today, not only do we find navigators in the more traditional aircraft, but we find them performing—and excelling—in F-4s, F-111s, SR-71s, and many other sophisticated weapons systems. The USAF navigator of today has truly arrived at a position of respect and responsibility comparable to his contributions to the overall 'fly and fight' mission of the Air Force.

"I don't believe that this change has been more dramatic anywhere than in the tactical Air Forces. SAC has long recognized the importance of the navigator corps to the successful accomplishment of its mission, and MAC pilots have long admired and respected the ability of the navigator to determine the position of the aircraft on long overwater flights. But until recently, the tactical fighter pilot was largely unaware of, and unexposed to, the navigator. It was not too many years ago that a navigator could walk through the halls of a fighter squadron, wing headquarters, and some MAJCOM headquarters only to be greeted by puzzled stares as the pilots tried to decide what sort of odd wings he was wearing—this is not so today!

"The contributions of the 'WHIZZOS' and 'GIBS' to the Tactical Fighter effort in Southeast Asia have once—and, I believe, for all—dispelled any hearsay or doubt about the professionalism, value, courage, or skills of the USAF navigator. I would be negligent at this point, if I did not also mention the absolutely vital roles played in Southeast Asia, and the enhanced prestige of the Navigator Corps, by Electronic Warfare Officers and Navigator-Bombardiers, both of which, as many of you know, are postgraduate navigators.

"In my mind, the value of the navigator has been proven beyond the slightest shadow of a doubt, and the future of the navigator is solidly established in those weapons systems currently in being, and in many of those planned for the foreseeable future.

"Even at the highest levels, the quality of the navigator force has been recognized in the repeal of that portion of Title 10 to the US Code that restricts navigators from operational command positions. Already, a navigator, Brigadier General (selectee) Eugene D. Scott, has been

selected to command an operational flying unit—the 47th Air Division, at Fairchild—and two Lieutenant Colonel navigators have assumed command of operational SAC squadrons. Here at Mather, in addition to our five Flying Training Squadrons, which are already commanded by navigators, we will soon be welcoming a new navigator Deputy Commander for Operations.

"I think it's important for everyone to fully understand this change. There has been a lot of emotion surrounding the issue and I think the Air Force cause is best served by discussing the question openly.

"Pilots and navigators alike need to understand that the repeal of Title 10 does not *give* command of flying units to navigators, it removes a restriction to command. Commanders of flying units will be selected on a 'best qualified basis,' and if a navigator is the best qualified man for the job, then he will, in all probability, be selected. Obviously, it is highly unlikely that a navigator would be selected to command an A-7 or A-10 Squadron. On the other hand, navigators in B-52, F-4 and F-111 Squadrons have every right to expect that they will be given the opportunity to compete—on equal footing—both for command now, and, probably more importantly, for the operations-type career broadening positions which will prepare them for command in the future.

"Changes associated with the repeal of Title 10 should not be expected overnight. The process of developing and training commanders is a gradual one, and one I am sure every navigator realizes the importance of. It is far better, in my mind, to adopt a cautious approach to the repeal of Title 10 and succeed on a best qualified basis than to 'charge' ahead and possibly suffer adverse consequences and setbacks.

"Another traditional career obstacle to the navigator, and navigator career development, has been the critical manning of the specialty in recent years. More specifically, during the conflict in Southeast Asia, we saw a number of even senior navigators returned to the cockpit from excellent career broadening positions because of manning shortages. But this picture is improving also.

"By the end of fiscal year 1976, it is estimated that there will be a surplus of navigators of roughly 15% over and above the crew and staff positions required. This will allow navigators—in numbers far greater than ever before—to seek the career broadening or the advanced schooling that is so essential to the development of our 'whole man' leaders of tomorrow.

"In short, I believe that the USAF Navigator of today has come of age, receiving credit due, and facing certainly the brightest career prospects in Air Force History.

"When considering the advancements of the navigator corps in recent years, it is significant to note that much of the credit for this success belongs to the young officers; and for the moment, I'd like to talk about them and the training they received, as opposed to what the students are receiving today.

"In retrospect, it is almost incredible to me that the young navigators graduating, up until about a year ago, were able to successfully transition into the Air Force beyond our gates. Here, they received their training in archaic—albeit durable—T-29 prop-driven aircraft, using equipment that many will remember as being old on the B-29, the B-50 and the B-36. We attempted to teach them the fine points of radar and celestial navigation at an altitude of 15,000 feet and a speed of 180 knots. Then we graduated them, and asked them to perform the same tasks— *better*— in aircraft flying 2 to 3 times as high and 3 to 4 times as fast, and to become proficient on the very latest avionics equipment that the Air Force had to offer—which they had never seen before. I think it is a tribute to the professionalism and sheer dedication of these young men and their instructors that they were even able to survive in the real Air Force, much less excel.

"Fortunately, times have changed. The first step in updating our program, and incidently the first major step at all in more than 20 years of navigator training, came in March of last year, when we introduced the T-43 jet aircraft into our training. Finally, after all those years and literally tens of thousands of graduates, we were able to offer our students a whole new program designed around the use of an aircraft which, if it could not duplicate the altitudes and speeds of the operational fleet, could at least approach them, and provide our graduates with the feel of operational flying and experience in utilizing and managing some of the most sophisticated avionics systems available anywhere.

"But even the T-43 and the modified undergraduate navigator training system, as it was called, did not resolve all of the problems or fill all of the training needs of the modern Air Force Navigator. A few ingredients were still missing.

"The first of these was what I'll call 'AIRMANSHIP.' For a number of years now, we have been doing our graduates a disservice in not fully training them for the aerial environment or the close-knit crew coordination procedures required throughout the Air Force. For too long we trained a technician, and not a man accustomed to wearing an oxygen mask or a parachute, or working closely on a one-on-one basis with a pilot, or making radio transmissions, or any of the other items that would have to be routine to him in an operational environment. We put wings on young men that did not even totally understand the jargon of a military aviator.

"The addition of the T-37 to the navigator training program in January of this year has done much to remedy this shortcoming, and enhance the airmanship of our graduates. I know it sounds a little strange, at first, to talk about pilots instructing navigators and using a pilot training aircraft to train navigator students. But that's the whole thrust of what I've been talking about. The Air Force Navigator today is not just the Magellan of 1975 or an updated version of the World War II Navigator. The navigator of today is an officer first, as always, but now he is an Airman, a crewmember and a systems manager, and not just the technician he used to be. The addition of the T-37 has done much to impress this upon our students. Today, we teach our young navigators what it's like to wear a parachute and an oxygen mask, and to sit on an ejection seat.

"We get them talking on the radios and teach them about who they're talking to, and why. We teach them to work as a team with the pilot sitting next to him, and in the process, teach him that a pilot is neither a god nor a monster, but rather just another professional young flyer like himself. We introduce our students to directing standard instrument departures in the T-37, and we teach him to direct and monitor instrument approaches. We teach him to talk to, and understand, ground control, the tower, departure control, air traffic control and approach control. We teach him to relate to the flyers' environment, and we make them navigate using the tried and true method of mental dead reckoning.

"We are delighted with the results we have seen, thusfar, and are very optimistic about the future of the T-37 in navigator training.

"Admittedly, though, the program is not yet complete. We are limited in what we can do with the T-37, and the T-43 does not provide the absolute optimum in individual training. The problem is simple, on an aircraft carrying 12 students, only one can be directing the aircraft at any time—the others must follow. As you can imagine, this is less than the optimum environment for training young students in the responsibilities incumbent upon the operational navigator.

"Happily, the solution to this problem is now being phased into the Undergraduate Navigator Training program in the form of the new, totally computerized T45 ground simulator. This remarkable new device provides us with heretofore unheard of capability to train our future navigators.

"In the simulator, we can fly students anywhere in the northern hemisphere up to an altitude of 70,000 feet and up to a speed of Mach two. We can provide digital radar landmass simulation, and radio aid, LORAN, celestial, and pressure pattern training. We can fail any piece of student equipment and introduce them to penetrating hazardous weather. We can also monitor individual students more closely and more objectively than ever before possible. But most importantly, each of our 52 simulator student stations is capable of independent flight. In the T45, which has the same avionics gear and nav cockpit arrangement as the T-43, each student is his own navigator—and totally responsible for the success or failure of his mission.

"I think you can readily understand the impact that the T45 will have on our program, and why we feel we are producing not only the finest navigator ever trained, but also a young officer, ready to meet any operational challenge or environment he might face. It is my sincere opinion that when our modern navigator graduate 'hits the streets' of the operational world, we will get questions like: 'Where are these new navigators coming from—are they still training them at Mather?'

"I wish time permitted me to talk about the similar advances and the quality of our advanced training programs, but unfortunately it does not. Let me assure you, though, that the programs are equally exciting and we are producing the most highly qualified electronic warfare officers and navigator-bombardiers the Air Force has seen.

"In closing, I would like to just briefly say that you can be proud of the Air Force navigator of today and confident of his professionalism and success in the future. We believe we have and are now training highly professional, totally dedicated young men, who will not only aggressively carry on the advances that have already been made, but will be prepared, as never before, to meet the new challenges and expanding horizons of tomorrow..."

Brigadier General Robert W. BAZLEY

Brig Gen Bazley began his Air Force flying career as a navigator during WWII. Qualified initially in the B-29, he also flew 50 combat sorties as an RB-26 navigator in Korea. He graduated from pilot training in 1954, and was assigned to an F-84 unit in England. Since then he has amassed over 4000 hours of flying time, including 257 combat sorties in the F-100 in SEA. Gen Bazley has also seen service as a recruiter, a member of the Commandant's staff at the AF Academy, and as a staff officer in both the Air and Joint Staff Operations Directorate. Since 1972, Gen Bazley has been a Base Commander and a two-time Wing Commander. Most recently, he was the Commander, 323 FTW at Mather. On 4 August, he assumed his current duty as the Inspector General, USAFE.

Captain Gerald R. J. HEUER
Headquarters Air Force Eastern Test Range
Patrick AFB, Florida

In your many "bag drags" around the world you have undoubtedly observed a C-135 with a "champagne cork" for a nose. This airplane is assigned to Headquarters Air Force Eastern Test Range (HQ AFETR), Patrick AFB, Florida. Its official nomenclature is EC-135N, or Advanced Range Instrumentation Aircraft (ARIA). Its mission is to fly worldwide, obtain and record telemetry data, in support of the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) missile test and space flight programs. Day or night, but mostly at night, the "water-wagon" ARIAs can be seen struggling off the ground and pointing their "snoots" toward some obscure position over the earth's watery surface. Once on station they await the launch of a missile or space vehicle and monitor its progress through the use of the world's largest airborne steerable telemetry antenna, housed in its nose.

The ARIA, based at Patrick AFB, Florida, 20 miles south of Cape Canaveral Air Force Station and the Kennedy Space Center, had its conception in the early 1960s when NASA recognized the need for a worldwide network of telemetry/ tracking stations for future Apollo space flights. Geographical and political constraints would not allow the placement of ground stations where they were most needed to cover the launch, orbital insertion and re-entry phases of the missions. Although NASA and the DOD possessed telemetry ships, these alone could not fill the geographical gaps between existing ground stations. Further, these ships could not move quickly to a new test support position without causing considerable delay in a launch; thus, the highly mobile ARIA flying "ground station" was born.

The fleet of ARIA was acquired from the Military Airlift Command when it converted from C-135s to C-141s. They were modified at a cost of four million dollars per aircraft (a small price in comparison to the cost of a ground station). Over 30,000 pounds of electronic and associated equipment were added. The most obvious change to the C-135 silhouette was the addition of a 10-foot radome on the nose to house the seven-foot steerable antenna. (This gave it the nickname of "droop snoot" or "snoopy.") Two wing probe antennae and a trailing wire antenna were added for worldwide communications. Later modifications added antennae to enable the ARIA to immediately retransmit telemetry data via satellite, or to "data-dump" this same information to a ground station during a flyby. These two processes decrease the time needed to assemble data at launch sites or engineering laboratories and to begin the arduous task of deciphering the telemetry information.

Inside ARIA, the cockpit resembles a normal C-135 with a few changes. There is an extra generator control for the added generator on number four engine which supplies power for the electronic equipment in the rear of the aircraft. An antenna position needle was added to the pilot's instrument panel to display azimuth information during certain telemetry tracking maneuvers.

The navigator station contains the usual equipment: APN-70 LORAN; APN-147 Doppler Radar; ASN-35 Doppler Computer; two sextants; two bearing heading indicators for the TACANs/ VORs; two ADFs; and an APN-59 Radar. An interphone panel was added to provide a private communication loop with the Mission Coordinator (MC) in the rear of the aircraft, ARIA Control at Patrick, or other aircraft. Because of the exacting mission requirements and the unusual deployment areas, an Inertial Navigation System (INS) has recently been added. Unlike the airlines, there is only one INS, so the navigator cannot "coast." A last and unique piece of equipment added was the Coordinated Universal Time (UTC) and countdown/ elapsed time display. This digital-readout clock provides essential mission timing information. During the hours of darkness, the one inch nixie lights of this unit are easier to read than a watch.

Leaving the flight crew compartment, you enter the world of the PMEE—an acronym for the Prime Mission

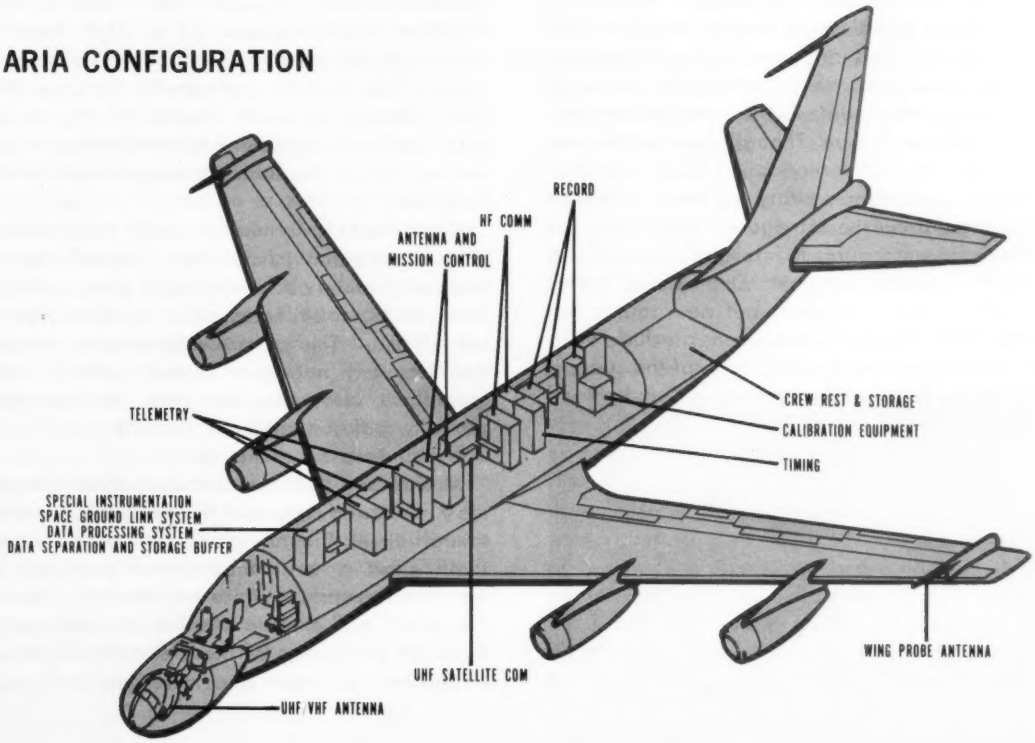
Electronic Equipment. The chief of the PMEE crew is the MC. He is the only officer in the back end of the aircraft. It is his responsibility to provide direction to the PMEE operators, and act as the interface between flight crew, PMEE operators, and ARIA Mission Control Center at Patrick. Next is the systems analyst, the NCOIC. He insures that all directives of the MC are fulfilled and provides technical assistance when required by the other operators. Having spent several years as an equipment operator himself, he is well versed in all functions of the PMEE operation.

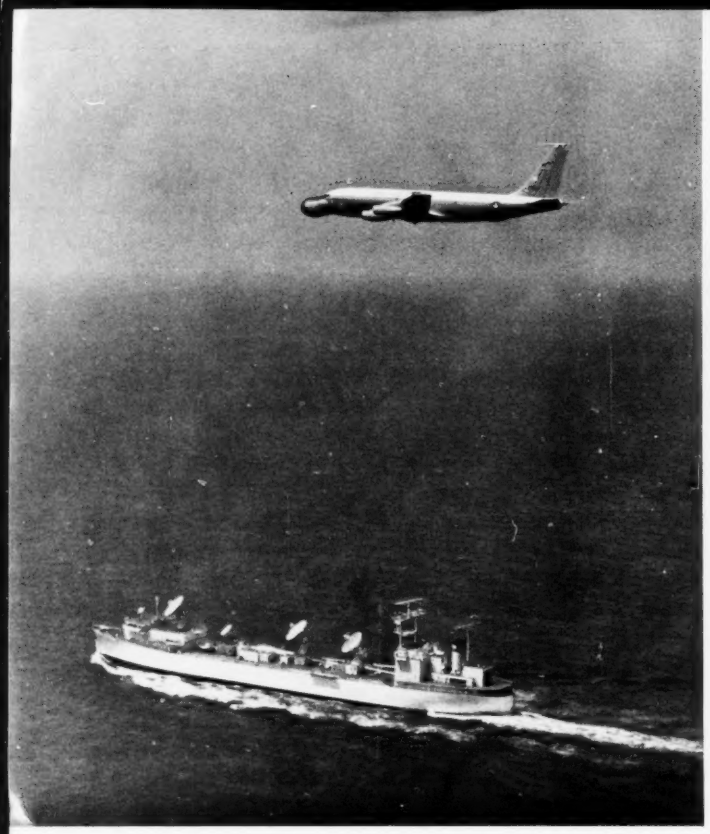
The antenna operator is the prime link between the aircraft and the space vehicle. His job is to acquire and track the vehicle as it broaches the horizon and maintain track until it either passes beneath the horizon or splashes down at the end of the re-entry phase. Once the signal is received, it is processed through the RF (Radio Frequency) Group. Here the UHF or VHF signal may be routed through specialized equipment for retransmission through the HF radios or a satellite, directly to a ground station. (Two RF operators monitor the progress of these signals during the data runs.)

Next the signal is processed by the record section. In the record section, data is recorded on two 14-channel tape recorders moving at 60 or 120 inches per second and monitored by the record operator. Later, this data will be evaluated at Patrick, Johnson Space Center, TX, Marshall Space Center, AL, Goddard Space Flight Center, MD, Goldstone Tracking Center, CA, or other using agencies. The record operator is also responsible for the ARIA timing system which provides timing information, accurate to .005 seconds to the PMEE operators, navigator, and mission data tapes. Although the record operator is at the end of the telemetry chain in the aircraft, there is one other "back end" crewmember who plays an equally vital role in the ARIA; he is the HF operator. At his disposal are three HF radios and associated equipment that allow him to maintain worldwide communications between the aircraft, ARIA Control, and using agencies. Through "patch networks" he is able to retransmit voice or telemetry data. Many of the real time voice relays between the Johnson Space Center and the Apollo/ Skylab astronauts were handled this way.

When a request is made by DOD or NASA for ARIA support, planning for the mission begins. (This could be months before an actual flight takes place.) A mission planner and mission engineer review the request accepted by HQ AFETR and begin initial planning. While the engineer reviews the technical requirements, the mission planner arranges for aircraft entry/ exit permits, operating rights, visas for the crew, altitude reservations (ALTRV), and enroute maintenance

ARIA CONFIGURATION





Data dump to tracking ship.

support. Two or three weeks before the mission is final, flight requirements are given to a navigator and he develops the flight planning details.

Worldwide ARIA deployments make it mandatory that the navigator be intimately familiar with the Flight Information Publications and the Foreign Clearance Guide. One month he may find himself flying to Mauritius Island in the Indian Ocean; the next month it may be to Tahiti or Europe. Though most nations are members of the International Civil Aviation Organization, procedures vary greatly between countries; therefore, the navigator must vary his mission planning procedures to insure all requirements of a specific country are met. Deployment routes usually follow normal airways, but new routes are constructed when diplomatic restrictions preclude overflight of a particular country. All facets of the support mission must be thoroughly planned and understood before the navigator leaves Patrick.

The primary objective of the support mission is to be at a Test Support Position (TSP) at a specific launch-plus-time (T+), accurate to one second. To accomplish this, the navigator plans to arrive at a predetermined geographical point called a Start Run Point (S/ R) (similar to an Initial Point),upstream of the TSP. At the S/ R, he establishes a timing pattern to control the arrival time at the TSP (see diagram). This problem is further complicated when a descent must be accomplished (e.g., FL 270 to FL 030). The planning phase is simplified by using computer flight plans provided by the USAF Global Weather Center (AFGWC), at Offutt AFB. The navigator submits his flight plan to AFGWC and they provide a TSP formatted computer flight plan. The Center also provides normal deployment /redeployment flight plans using ARIA route information stored in their computer.

Once the navigator has received his "planning forecast," he coordinates with the pilots to establish mission fuel requirements, the intent being to provide the using agency with the longest possible "support window" (the amount of flight time that the aircraft can remain in the support area and still complete the mission). Many times, missions are flown so far from the staging /recovery bases that the support window becomes quite small and effort must be made to increase the size of the window and still remain within the directives of AFR 60-16. The need for increased window time becomes quite apparent when primary mission launch delays occur after takeoff. Any extra time that can be provided to the user may prevent rescheduling of a mission.

Coordination must continue with the mission planner and mission engineer to insure that all technical requirements for the mission are met. Errors could jeopardize the safety of the aircrew. (This is particularly true on missions supporting re-entry. Ablative material separates from the space vehicle as it enters the atmosphere, 12 to 30nm from the test support position.)

Two days prior to deployment, the crew attends a final briefing. Here all aspects of the mission are reiterated and any new problems or requirements are worked out. (In this business, requirements often come very late.)

Deployment for a mission usually begins seven days prior to the actual mission day. The early departure is to insure that the aircraft will be in place at the staging base at least 24 hours prior to scheduled mission takeoff time. This permits maintenance personnel to complete any necessary repairs prior to scheduled takeoff. It also gives the crew an opportunity to partially adjust (physically) for the cicadian rhythm effect of time zone changes.

Mission day finds the aircrew at base operations at least two and one-half hours prior to scheduled takeoff time. The navigator compares his computer flight plan against information provided by the weather forecaster. Winds are studied. Cloud cover, "D values" and enroute weather are also analyzed. A thorough evaluation of these elements is required to determine the proper departure time and insure on-

time coverage of the missile launch. The navigator makes the final decision concerning takeoff time. Concurrently, the pilots recompute fuel expenditures based on present weather conditions. When all the necessary determinations are complete, a telephone call is made to ARIA Control, confirming that the missile countdown is proceeding on schedule and advising of any changes in planned takeoff time or launch window support time.

Prior to takeoff, direct HF contact is established and maintained with ARIA Control to insure that there have been no alterations made on the launch schedule. ARIA Control continues to monitor the progress of the aircraft from the initial contact to arrival at the TSP. "The best laid plans of mice and men..." No matter what the navigator has put on paper during mission planning, the mission normally does not proceed according to his plan. After takeoff the navigator concerns himself with airspeed and course changes to make the TSP time good. Although the ARIAs now possess INS, the workload is not reduced. (It is made somewhat easier, however, especially when deviations are required for weather.)

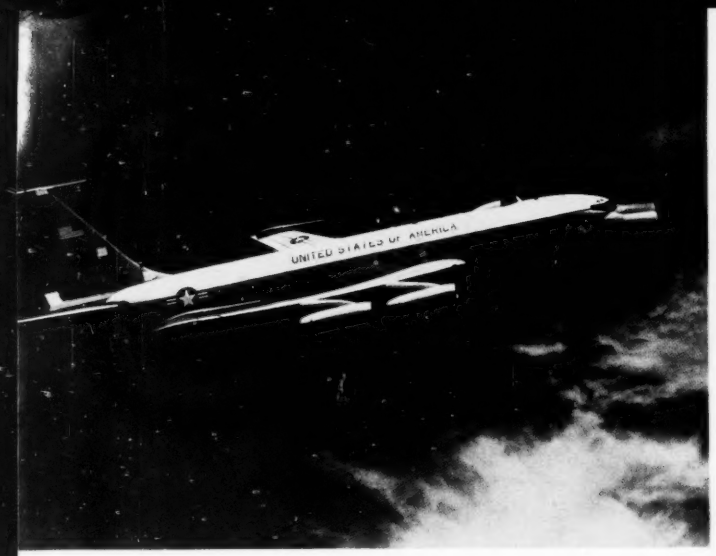
A majority of the missions pass through, or take place in, the Inter-Tropical Convergence Zone (ITCZ). Anyone who has flown in this area is aware of the potential weather problems. Track deviations in excess of 100nm are not uncommon. Overcast skies and twilight flying make the use of celestial navigation extremely difficult if not impossible. Many missions are flown south of the equator, where LORAN is of little or no use. There, the navigator must rely solely on dead reckoning, aided by Doppler and celestial. The INS is not infallible, and while circular errors of 20 miles or greater are not common, they are possible. It behooves the navigator to constantly cross-check his INS with other navigational aids.

Should it become impossible to arrive at the TSP at the required time (due to any number of factors: adverse head winds, weather, a late takeoff) , the navigator must alert ARIA Control. He must explain the problem and request that revised TSP coordinates and a new control time be generated. The information he provides is inserted into a computer. New support requirements are generated by the computer, transmitted to the aircraft, and printed-out by an on-board teletype. Included in this transmission are new "look angles" for the antenna operator. "Look angles" are magnetic bearings of the space vehicle (in azimuth and elevation) as it relates to the aircraft's position and heading during the run to the TSP.

After two to three hours of enroute navigation, the aircraft arrives in the support area. The navigator must now tackle the problem of departing his S/ R position precisely on time to meet his TSP time commitment. This is accomplished through the use of a race track timing pattern bounded by 180-degree turns at each end. To control the departure time, the navigator notes his time over the S/ R point and begins a one-degree per second turnaway from the point. While in the turn, he will have to vary his TAS to make good the planned groundspeed. Should an adjustment be required, he consults a nomagram to obtain the proper bank angle required to maintain a turn of one degree per second. Having solved these variables, he notes the time to run outbound and starts his stop watch when the pilot has rolled-out on the reciprocal of the run heading. When the computed time has elapsed, he turns the aircraft back toward the S/ R point. Simple enough? Not always! Strong cross winds destroy the timing pattern; not so much in relation to time, but in terms of displacement from track. Occasionally, the wind experienced inbound to the S/ R point is different from the wind outbound. Also, the pilot may not maintain a turn of exactly one degree per second. Each of these anomalies must be instantly evaluated and corrected by the navigator to insure meeting the proper S/ R time.

If a descent is to be made, other problems occur. The obvious one is controlling track while descending through levels of changing winds. That problem is minor compared to the problem of time control. Airspeeds and bank angles must be varied for proper time control. Mission planning alleviates some of the problem, if the descent is planned using an average TAS based on a mid-altitude. This procedure normally works if the aircraft is allowed to descend at the proper time. Any delay in receiving altitude clearances finds the flight crew uttering a few expletives. In the end, all semblance of planning is thrown out and "good ole seat-of-the-pants" flying takes over as the descent is completed. The backenders sometimes feel that the flight crew is intent on doing them bodily harm, as descent rates and bank angles are changed in the process of making good that time.

ARIA fleet at Patrick AFB.



ARIA presents unusual profile.

Each navigator in our outfit has executed the perfect timing pattern (to the tenth of a second), only to hear ARIA Control say, "We are in a hold at..." as he crosses his S/ R point. Should the mission go into a hold, airspeed is reduced to the slowest allowable and the pilots and flight mechanic begin recomputing fuel requirements for the remainder of the mission. Every effort is made to "make fuel" for the aircraft and, hopefully, increase the time on station. To decrease fuel consumption, the orbit pattern is increased, because turns require more power. (However, the navigator cannot let the aircraft proceed too far from the S/ R point, as mission countdown could resume at an unexpected time.)

When the timing pattern is completed, the navigator places the aircraft on the heading toward the TSP, takes one last look at his radarscope for weather, and places the APN-59 in "stand-by." (This is necessary to prevent any transmitted radar energy from reflecting off the back of the telemetry antenna and burning out the radar's R-T unit.) The antenna operator then brings the tracking antenna out of stow and steers it into a predetermined tracking position.

The navigator must mentally plot the track and distance the aircraft will fly on the data run to insure all adverse weather is avoided. Normally, the orbit and track of the data run have been altered beforehand to avoid the bad weather. However, when descents are made into weather, the situation is not always resolved until after level-off. (Of course, this always happens when the MC needed the antenna 30 seconds ago and the aircraft was still in its turn toward the TSP.)

The data run is made holding a pre-determined true course or true heading. Any deviation from the planned is immediately passed to the MC because heading changes affect the look angles of the antenna operator. During the data run, silence is maintained on the crew intercom. The flight crew intently listens for the word "AOS"—Acquisition of Signal. When AOS is announced, the navigator looks at the digital clock, notes the time and aircraft position, and heaves a sigh of relief when the clock time matches that predicted for AOS. Nothing to do now but settle back, enjoy the run and make minor adjustments in airspeed and heading to insure TSP time and proper track.

After crossing TSP, the navigator notes his position and waits for the word "LOS"—Loss of Signal, at which time he again records the aircraft's position. If it is a re-entry mission, the flight crew may be treated to the sight of an exploding skyrocket and a thousand falling stars as the vehicle re-enters the atmosphere, burns up, and splashes into the ocean, just ahead of the aircraft!

When the data run is terminated (and the crew is so advised by the MC), the navigator directs the aircraft toward the recovery base, three to four hours away.

On the way home, the navigator will complete a mission debriefing sheet concerning the data run. This will be turned in with the mission data tapes and used by the test engineers to evaluate mission technical data. If the data is needed in a hurry, a "data dump" will be accomplished. If not, the tapes are delivered to a tracking station at the recovery base for retransmission. The mission complete, the ARIAs return to Patrick and await the next assignment.

The ARIA fleet flys over all the oceans of the world in support of the space and missile requirements of the Air Force Eastern and Western Test Ranges. Included in the ARIA support role are many programs of national importance such as Apollo, Skylab, Pioneer, and Mariner for NASA; Polaris, Poseidon, Minuteman, Titan III and Trident for the DOD. The mission is a most interesting, varied and challenging one for the navigator. But then, IT IS A NAVIGATOR'S MISSION!

Captain Gerald R. J. HEUER

Captain Heuer entered the Air Force in September 1964 after graduating from the University of Michigan and was assigned to James Connally AFB for navigator training. Since graduation, he has been assigned to the KC-135, C-141, AC-119K, OV-10, and EC-135N aircraft. While in SEA, he served as an instructor in the USAF/Vietnamese Air Force AC-119K gunship school. He has been stationed at Patrick AFB since his return from SEA in 1973.

Navigator's Chart Quiz

Mr. John H. HARDEN, Jr.
Defense Mapping Agency Aerospace Center
St. Louis AFS, Missouri

The following questions are intended to test your knowledge of DOD Navigation and Planning Charts and related products on the premise that a better understanding of cartographic products promotes a safer and more effective mission. In the true spirit of Undergraduate Navigator Training, please select the most nearly correct answer. Answers and the reasons why can be found on page 14.

1. A straight line on the Operational Navigation Chart (ONC) is a Great Circle course. True or False?
2. Where possible, you should join charts of the same series together, matching:
   a. aeronautical information to aeronautical information
   b. feature to feature
   c. projection to projection
   d. both b and c
   e. none of the above
3. On a conformal chart, size and true shape of areas are correctly shown. True or False?
4. Which of the following chart terms apply exclusively to grid navigation?
   a. apical angle
   b. graticule
   c. isogonics
   d. isogrivs
   e. a and d above
5. A large scale chart, compared with a small scale chart, shows less of the earth's total surface and also shows a specific area smaller. True or False?
6. Match the following symbols and definitions:

a.
b.
c.
d.
e.
f. 12770
g.
h.

   a. bakran (dune)
   b. ruins
   c. powerline
   d. dam
   e. cave
   f. falls
   g. fence
   h. fort
   i. accurate elevation
   j. doubtful elevation
   k. doubtful location
   l. rapids

7. All symbols on the chart are usually shown in the legend. True or False?
8. Which of the following update(s) the aeronautical chart?
   a. NOTAMs
   b. FLIPs
   c. CHUM
   d. b and c
   e. all of the above
9. The JNC is a larger scale chart than the GNC. True or False?

10. The preferred chart for target area radar prediction is the:
   a. ONC
   b. ATC
   c. TPC
   d. JOG AIR
   e. none of the above
11. The CHUM is published:
   a. monthly
   b. quarterly
   c. semi-annually
   d. annually
12. Gnomonic charts are the best choice for long-range flight planning. True or False?
13. What do you refer to for information on obtaining replacement charts?
   a. CHUM
   b. Chart Bulletin
   c. Chart Bulletin Digest
   d. DOD Catalog of Aeronautical Charts and Flight Information Publications
   e. b and c above
14. The_____tell(s) you the current chart edition in the field.
   a. Chart Bulletin
   b. Chart Bulletin Digest
   c. DOD Catalog of Aeronautical Charts and Flight Information Publications
   d. a and b only
   e. all of the above
15. You can safely use any edition of a chart so long as it is not stamped "Hazardous." True or False?
16. Which one of the following is not concerned with relief information?
   a. hachures
   b. contours
   c. spot elevations
   d. terrain tints
   e. none of the above
17. When constructing the chart, the cartographer includes all features that, in his opinion, would be useful to the user. True or False?
18. Drainage is normally shown as a perennial (solid line) stream if it contains water throughout the major part of each year. True or False?
19. Glaciers are as accurately contoured as terrain. True or False?
20. In one five-year period, how many Air Force aircraft were destroyed and how many men were killed as a result of geographic disorientation?
   a. 12 aircraft and 8 men
   b. 26 aircraft and 57 men
   c. 44 aircraft and 57 men
   d. all of the above
   e. none of the above

Answers

Give yourself 5 points for each correct answer (½ point for each part of question 6). Don't take your score too seriously. These questions were intended to inform you of useful chart information that is frequently misunderstood. But just for fun...

1. False. A straight line on the ONC *approximates* a Great Circle.
2. The correct answer is c. All chart information is positioned relative to the projection. Joining by feature to feature (aero or otherwise) is not reliable since adjoining charts may have different currency dates and therefore reflect differing feature portrayal of the same area.
3. False. Direction and true shape are shown correctly on conformal charts, but not size.
4. The correct answer is e. Isogrivs are lines of equal grid variation. The apical angle is the angular difference of the convergence of the navigation grid at 180° longitude.
5. False (Partly True). A large scale chart does not show less of the earth's total surface, but shows a specific area larger.
6. a. l
   b. a
   c. c
   d. c
   e. g
   f. j
   g. e
   h. h
7. False. The legend contains only those symbols that, in the opinion of the cartographer, need explanation.
8. The correct answer is e. The CHUM, along with FLIPs and NOTAMs update the chart with all *known* chart discrepancies which could affect flight safety.
9. True. The JNC is at 1:2,000,000 scale and the GNC is at 1:5,000,000 scale.
10. The correct answer is b. The classified Air Target Chart (ATC) Series 200 chart (1:200,000 scale) shows radar return information.
11. The correct answer is c. The new publication cycle for the CHUM is semi-annually with monthly cumulative supplements.
12. True. Although its graticule is greatly distorted, the gnomonic projection is the only projection that shows a great Circle course as a straight line throughout the projection.

13. The correct answer is d. Section II of the DOD Catalog contains chart replacement information.
14. The correct answer is d. The Bulletin and Bulletin Digest together contain current chart edition information.
15. False. Only the current edition as listed in the Bulletin and Bulletin Digest can be used. Previous editions are obsolete and can be considered hazardous to flight.
16. The correct answer is e. All choices are concerned with relief. Hachures portray terrain by short, wedge-shaped lines radiating from high elevations to low elevations following the direction of slope.
17. False. The cartographer cannot include all navigational features without cluttering up the chart. He selects representative features based on the limitations of scale, and his own judgement as to their usefulness, considering the design purpose of the chart.
18. True. If it contains water for a lesser period, it is considered nonperennial and shown by broken lines.
19. False. They cannot be accurately contoured, since they usually are slowly, but constantly, changing in shape.
20. The correct answer is c, which equates to about one man and one machine per month. Answer d (all of the above) represents the total Army, Navy and Air Force losses. The figures are not a true measure of the problem of geographic disorientation since they do not include the aircrew members who got lost and survived the experience by making a forced landing, bailing out, or regaining their orientation. The significance of this data is obvious, and emphasizes the need to understand the characteristics and capabilities of charts. This is a freebie. Give yourself 4 points.

Scores

5-24 Lost! Ask the pilot for a Tacan range and bearing—frequently.

25-49 Temporarily disoriented. Always have an IN Flying with you.

50-67½ Good ole Nav, on course and on time. Your best friend is DR.

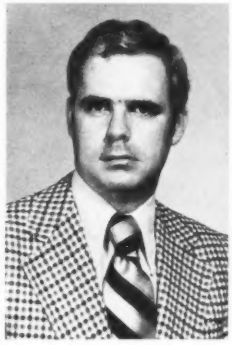
68-83½ Minimum magnificent. You can tell pilots where to go with considerable skill.

84-95½ Don white cap and scarf. Go directly to Stan/Eval.

96-99 Sierra Hotel! Have the pilot carry your nav bag.

Mr. John H. HARDEN, Jr.

Mr. Harden graduated from the University of Georgia in 1966, majoring in Physical Geography. Following ROTC commissioning and flight training, he was assigned to the 99 BMW, Westover AFB, as a B-52 navigator. Subsequently he completed the Cartographic Officer Course at the Aeronautical Chart and Information Center in St. Louis, Missouri. Mr. Harden has since left active duty and works as a Cartographer at the Defense Mapping Agency Aerospace Center.



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Navigation in Oc

Captain Bob BLANKMANN
United States Military Academy
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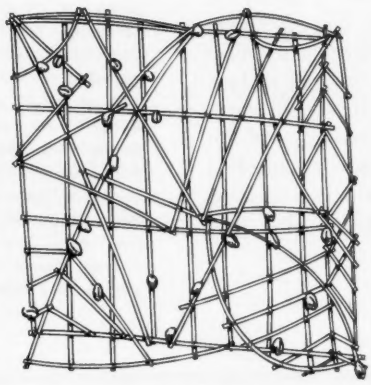
INTRODUCTION

The problem of getting from point A to point B in an efficient and timely way is as old as the human species. The man who calls himself a navigator is a professional in the sense that he "professes" the ability to perform this minor miracle reliably and repeatedly. His expertise—a peculiar blend of science, art, and some say magic—derives from his mastery of a tradition which is ancient and honored. As navigators, we are both the beneficiaries and the exponents of that tradition and proud of it. This article is designed to lend factual substance to that pride.

Throughout my tour at UNT in 1970, I was intrigued by an odd piece of paraphernalia which hung on a wall in Bleckley Hall at Mather AFB. Illustrated here, it was a two-foot-square construction of wood-strips and cowrie shells, identified by its plaque as an island navigation chart from the Pacific. It always made me feel very much at home, as I had been absorbed in a graduate program of cultural anthropology not six months before. My casual interest was recently brought into focus by an article entitled "Wind, Wave, Star and Bird" (Lewis, David *National Geographic* December, 1974) discussing sea-navigation techniques of the Pacific islanders. The system of skill and knowledge, described below, is an appropriate point of departure for an exploration of the navigator's professional heritage. Because this particular system of navigation is preliterate, historically separate from our own, and fairly well-documented, it serves as a hypothetical model for the earliest "state of the art."

First a cursory look at geography. It is no exaggeration to term the Pacific—Oceania—a maritime wilderness. Comprising an area as large as Asia, its myriad of islands have been inhabited at least 1500 years. The migrations which account for this remarkable fact are thought to have originated in New Guinea and Indonesia some 5,000 years ago. It is therefore no surprise that virtually all the cultures of this region have always been and still are thoroughly oriented toward a seafaring way of life.



Current and Island Map.

Legends tell of impressive voyages: from Nuku Hiva in the Marquesas to the Hawaiian chain, 2,000 miles; from Tahitia to New Zealand, 1500 miles. It is reported that as late as 1771 a Tahitian aboard Captain Cook's ship *Endeavour* was able to provide an accurate heading from Java to the Society Islands. Unfortunately, at the time of European contact, no one collected systematic information on how such feats were performed, and now they are no longer attempted.

Some insight, however, may be gained by looking at techniques of navigation still in use for more modest trips, such as the one reported by Lewis in *National Geographic:* 500 miles across open ocean from Puluwat Atoll in the Caroline Islands to Saipan. Much of the detailed information to follow derives from Puluwat because it still has an active tradition of seagoing navigation: 15 ocean-going outriggers and 18 practicing navigators with some 73 crossings to their credit in the last two years. In addition, Puluwat was thoroughly studied in 1969 by anthropologist Thomas Gladwin (*East is a Big Bird,* Harvard University Press, Cambridge, 1970) with special attention to navigation. It is possible, using Gladwin's format, to divide a typical crossing into three segments for descriptive purposes: departure, enroute cruise and landfall.

DEPARTURE

The first task is setting the course. On very short trips, rudimentary means are adequate. That is, the navigator simply has in mind a sight-picture of what his island of departure looks like when he is on the proper heading to his destination. If possible, though, he will coast out on a visual line-up of two topographic features of his departure island for greater accuracy. On the same principle, navigators in the Gilbert Islands still make use of markers erected by their forefathers for this purpose.

More sophisticated, and in fact more common, is the use of celestial references. Systems are documented from the Samoan, Gilbert, Santa Cruz and Danger Islands. *Gladwin* has provided a schemata of celestial knowledge on Puluwat, depicted in Figure 2. It is used in conjunction with a sizeable

eania

repertoire of celestial formulae; one for each possible combination of some 26 islands regularly contacted. For example, to set a course for the island of Truk (due east of Puluwat) the navigator departing at evening twilight merely steers directly toward Altair as it rises above the horizon. Departing for Satawal (directly to the west) the navigator "backsights" on Altair as it rises or waits until first light and steers toward it as it sets in the west. It is interesting that this "celestial rose" is more finely incremented at its east-west poles than at the north and south. This is a practical accomodation to the fact that the Carolines Islands themselves are oriented east-west, hence rewarding finer discrimination along that axis. The rose does not reflect the fact that Puluwatan navigators also make use of some 140 other stars as substitutes for those mentioned. These substitutes are employed when the "primaries" are not at optimum altitude for azimuth determination.

The sun is also used according to this same principle. From some familiar location, usually his canoe-house, the navigator notes the horizon-point at which his heading-star rises in reference to some topographic feature on his island. Later he notes the bearing relative to that topographic feature at which the sun rises. Upon departure, during the early morning hours while the sun is still low in the sky, he then makes good this relative bearing, confident that he is steering toward his heading-star even though it is not visible. He makes good this bearing by use of some convenient measure: e.g. the arc subtended by the tips of the thumb and middle finger on the hand loosely extended at arms length = 15 degrees; the width of the thumb at arms length = 2 degrees, etc. I can find no reference to the use of either the moon or the planets for navigational purposes. On Puluwat their regularities of transit are considered too complex to be useful.

In setting the course consideration of both ocean current and wind are also involved. Navigators on Puluwat have memorized certain standard corrections to compensate for these effects for each of their many routes of travel. The correction factors are stated and applied in terms of increments of the "celestial rose." In other words, just as we conceive a true course, between points and correct it for variation and wind, they conceive a true course which they correct for wind and ocean current. The standard corrections are made routinely upon departure and are evaluated against conditions actually encountered. This is done by noting the drift experienced (using the wake of the craft as an index relative to the point of departure) much as we would use a driftmeter or observe a point tracking down the cursor on a radarscope. Additional corrections are made as necessary. In other parts of the Pacific, where ocean current and wind conditions are less stable than those in the Carolines, there exist quite elaborate nomenclatures for the description of various ocean current wind combinations according to type, rate and direction.

ENROUTE CRUISE

As in aerial navigation, once the course is set it must be maintained. Since World War II, the magnetic compass has been widely used. It is never used to set a course initially, however. In other words, a directional gyro unslaved to any absolute reference point would serve this limited purpose just as well.

Two traditional means of maintaining course are still widely used, and require far more skill and experience. First, the sail is constantly trimmed in order to continuously compensate for changes in the strength of the ocean current and wind. The navigator's senses themselves must substitute for the true airspeed meter and Doppler. In theory errors tend to be random and therefore noncumulative. Second, constant attention is paid to the angle of the attack on certain very stable deep-sea wave formations. These are presumably generated by equally stable winds, such as the northeast trades. The proper angle-of-attack is not determined until the craft is well clear of any potentially disruptive landmasses, much as we wait to initiate pressure pattern work until we are well overwater. The angle of attack, once determined, is not made good visually, though the wave fronts are identifiable by that means. Rather, this is accomplished "by the seat of the pants," the navigator himself acting as a pitch and roll sensor. Ideal passages are those in which the craft tracks either perpendicular or parallel to the wave fronts, so that discriminations need be made only with respect to either the roll or pitch axis.

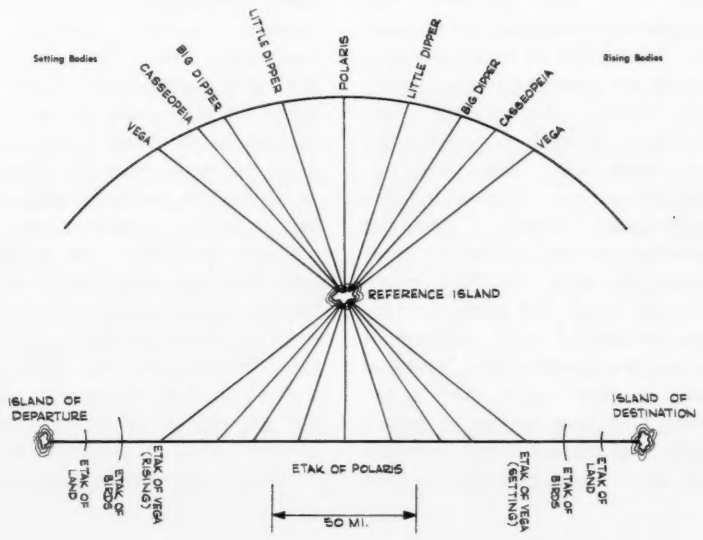
As a final aid to maintaining course, where possible, passages are planned so as to take advantage of submerged shoals and reefs. The navigators of Puluwat are familiar with each and every such formation (each of which has its utterly unique shape) within a 250-mile radius of their island. To the skilled navigator, the presence of such submarine features is signaled by variations in the color, temperature and surface conditions of the water above them, even though they often lie at considerable depth. According to their shape, they may provide Lines of Position (LOPs), or even precise fixes. A navigator may rely rather heavily on such aids, even at night and on passages up to 40 miles.

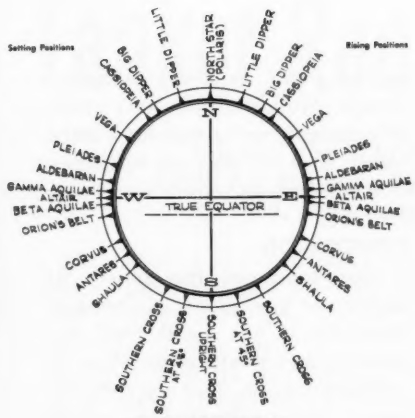
The final problem of enroute navigation is that of monitoring progress along course. The concept employed on Puluwat is termed *etak*, which roughly translates as "checkpoint." On each passage there is first the *etak* -of -departure (the checkpoint beyond which the point of departure is no longer visible). This can be 10 to 15 miles depending upon the elevation of the land mass. Next comes the *etak* -of -birds (the checkpoint beyond which birds will not habitually venture). This can be another 10 to 15 miles, depending upon the species of bird. There are, of course, two comparable *etak* at the end of any passage as the craft approaches its island of destination.

Enroute *etak* are determined by the intersection of track with abstract constructions which may be loosely termed LOPs. These "LOPs" are determined in two ways by using some landmass approximately 50 miles to the right or left of course, roughly midway in the passage, some celestial reference point on the horizon beyond the landmass. This line is not a true LOP since no actual sighting can be made on so distant a landmass. Rather it is a highly intuitive construct, analogous to our mental process of continuously computing an always-changing heading to an emergency airfield. Of course the celestial reference is periodically visible as an objective check on the accuracy of the process.

Considering very long voyages (though they are things of the past) there is also the consideration of zenith stars. In the Society and Marquesa Islands it is common knowledge among navigators, even today, that when Arcturus is directly overhead one has reached the latitude of the Hawaiian Islands. Upon reaching that point it would be an easy matter to simply turn due west, and effect a landfall in Hawaii by keeping Arcturus at its zenith all the way. When one considers the fact that contemporary navigators claim the ability to estimate the zenith of a celestial body within about two degrees, this technique is a very plausible one. The credibility of this technique is

Departure — Enroute Cruise — Landfall.





STAR COMPASS
after Goodenough (1953)

enhanced by the fact that Europeans used essentially an identical method before 1762 (when the chronometer was perfected sufficiently to allow accurate calculation of longitude). Western navigators of that era, however, were not limited to the use of zenith bodies nor to purely visual estimates of celestial altitudes, thanks to the astrolabe.

In reference to long voyages much speculation has surrounded the possibility that the seasonal long-distance flyways of certain migratory birds were followed, e.g. the curlew, plover, or cuckoo. The question remains open, as legend provides the only available evidence. One new fact has recently been established, however: the migratory birds do have the requisite navigational abilities to serve as guides, whether or not these birds were actually used.

The idea has also been entertained that major deep-sea currents were followed on exceptionally long voyages. This could be done by reference to the characteristic color, rate or temperature of the water. Contemporary western navigators can and still do, make such discriminations despite an otherwise impressive array of technical aids to rely upon.

LANDFALL

Having set and corrected the course, monitored and maintained it, the only remaining problem was landfall. This is effected in a wide variety of ways throughout the Pacific, depending to a great degree upon local conditions. In the Carolines, at least during the day, birds are invariably the first indication of proximity to land. The white tern, in particular, can be depended upon to fly away from the nearest land at dawn (out to a range of about 25 miles) and head inbound at dusk for overnight roosting. During the day it ranges at random within this radius (unless observed holding a fish cross-wise in its bill, in which case it will invariably be flying to the nearest landmass to eat its catch.) If one is fortunate enough to be bound for an island where boobies roost, the solution to the landfall problem is automatic. These considerate seafowl may be relied upon to hover above a craft virtually all day long, and at dusk lead it promptly and directly to shore. Lastly, on a night when the wind is right, any bird cry will tell the navigator that he is within 10 miles of land. He can relax and await first light.

Throughout Oceania flotsam is a useful sign of land, as are the smells eminating from land, and the sound of breakers. However, these signs are extremely vague and hence risky. But, then again, what navigator would ignore such indications when all others fail? Land sighting itself is, of course, the most reliable landfall technique. This technique does have the disadvantage of requiring a circular error of no more than 10 miles (except in cases of extraordinary elevation of volcanic activity.) In this connection it is well to recall the story of a crew that somehow weathered a severe storm on their 900-mile journey from Wolei Atoll in the Carolines to Kapingamarangi. After returning home, they regaled their comrades with a detailed accounting of their prowess, carefully omitting the inexplicable fact that in the one short year between visits, Kapingamarangi's inhabitants had completely changed their language!

In the Tuamotus characteristic, high cloud formations can be observed over land at great distances. These are often accompanied by a tell-tale greenish hue on the underside of the clouds. This phenomena results from sunlight being reflected from the bottoms of the large shallow lagoons found throughout this group of islands. In the Santa Cruz and Gilbert Islands there exists a form of (uninvestigated though often observed) submarine bioluminescence. According to David Lewis, "Streaks, flashes and momentarily glowing plaques of light...dart out from directions in which islands lie. The phenomenon is best seen eighty to a hundred miles out and disappears by the time a low atoll is well in sight."

There is also the "land screen" technique. Lewis illustrates the principle as follows. From Samoa, the Cook Islands, the Tuamotus and the Marquesas subtend a total of 48 degrees of arc. Any heading the navigator might choose to sail within 40 degrees will result in a landfall sooner or later. In the words of a Tongan proverb: "It is only necessary to hit the *row* of palm trees." In contemporary terms, it is a lot easier to find the continental US flying eastbound out of Midway than it is to hit Midway flying westbound out of the continental US.

In the Marshall Islands, landfall is more systematically effected by means of swell patterns. These result when the major wave fronts driven by the trade winds collide with their own reflections from nearby islands. Grossly over-simplified, when such an interface is reached the navigator turns to parallel it and tracks landward. The stick cowrie shell chart (previously mentioned) was made and used in the Marshall Islands. The specimen illustrated (a type

known as *rebbelib*) depicts the entire archipelago. The cowrie shells mounted on it represent landmasses. When compared with our own charts, they show spatial relations with sufficient precision to allow the identification of specific islands. Two other types of stick charts exist. (One is much more detailed, a "sectional;" the other is highly conventionalized, and used to teach the theory of wave propagation to novices.)

An episode from the oral history of Tonga suggests one other, almost uncanny, technique for effecting a landfall. Around 1820 (as the story goes), King Taufa'ahau and his convoy were attempting the return voyage home after a tatooing ceremony on Samoa. His navigators found themselves "temporarily disoriented." Kaho, a navigator of low rank who was blind and nearly deaf with age, learned the nature of the dispute from his son Po'oi. With great effort the old man leaned over the bow and trailed his hand in the sea for several minutes, then announced, "Tell the king we are in Fijian waters. When the sun has reached the middle of the sky we will see land." Within several hours his prediction proved correct. To express his appreciation, the king knighted the old man. To this day his descendants, the elite of Tongan navigators, are known as *Fafakitahi*—Feelers of the Sea. Koho's great-grandson recently confided the Po'oi had in fact sighted a seabird peculiar to the Fijis and mentioned it to his aged father. Kaho's technique might well be termed "show biz."

SOCIAL ORGANIZATION

Gladwin's research on Pulowat Atoll in the Carolines also provides interesting insight into the less technical aspects in the practice of navigation there. Six of the 18 practicing navigators are considered "masters" in tribute to their seniority and skill. They enjoy social status and prestige substantially beyond that of their chief or the canoe-builders. There is no such thing as a "canoe pilot." Cognizant of their great social stature, the navigators are apparently quite self-assured. So much so that they no longer find it necessary to traditionally display their esotheric knowledge at public initiation ceremonies.

Nevertheless, the apprenticeship of young navigators is as protracted and disciplined as ever. Star-course formulae, departure corrections and enroute fix points are painstakingly committed to memory through constant recitation and testing on land. The geometry of etak and the celestial rose are explained with the aid of pebble configurations and diagrams in the sand. At sea, under supervision of the senior, the students learn to apply this knowledge and acquire the subtle discrimination necessary to recognize wave-fronts and shoals; trustworthy birds; and detect changes in wind and ocean current.

It is recognized that not all young men will even attempt this training. It is accepted that not all who do will ultimately qualify. In fact, attrition exceeds 50 percent. Moreover, an individual's failure is not considered a fit topic for casual conversation.

The father-son relationship is considered the ideal context in which to teach and learn navigation. More often, however, less intimate kinship ties relate the student and teacher. Although secrecy shrouds certain finer points of technique, navigators have been known to teach their art elsewhere in the Carolines, albeit for a very stiff fee.

CONCLUSION

Thus concludes this survey of preliterate navigation in Oceania. Hopefully it has heightened the reader's awareness of himself in his professional role. That has certainly been my experience while researching and writing it. So much so, I plan to continue this exploration of cultural time and space. My itinerary includes the voyages of the Vikings and Phoenicians; caravans across the Sahara and central Asia; treks through the polar barrens of Asia and North America; trips in the Indian Ocean aboard Arab dhows; and sailing on junks in the China Sea. It is my contention that we as contemporary navigators tend to lose ourselves in the multitude of technological and scientific paraphernalia aboard our craft, and tend to forget our basic rudimentary senses. (In the words of AFM 51-40): "Navigation is considered both an art and a science. Science is involved in the development of instruments and methods of navigation as well as in the computations involved. The skillful use of navigational instruments and the interpretation of available data may (read-must) be considered an art."

Captain Bob BLANKMANN

Captain Blankmann graduated from Yale University in 1967. He was commissioned through OTS. Upon completion of UNT, NBT and CCTS, Captain Blankmann was assigned to the 441 BMS at Mather AFB. In 1972, he was deployed to Guam for participation in SAC's "Bullet Shot" operation, earning the DFC and AM with three OLC. Captain Blankmann is presently teaching Cultural Anthropology at West Point.

Tanker Radar Distorts the Truth !

Captain Jim WATTERS
509th Air Refueling Squadron
Pease AFB, New Hampshire

This is not an article designed to make you hate the tanker radar, although the APN-59 does have some weak points. This article is meant to help you make better use of your radar.

Put yourself into a Doppler-out, day celestial situation and assume for the moment you wish to obtain a Target-Timing Wind (TTW) for your next DR. From your instruments you record the following:

TH = 270° TAS = 400K

From your radar you obtain the following information:

TGT 1:	297° / 22nm	
TGT 2:	309° / 17nm	Elapsed Time:
TGT 3:	327° / 13nm	2 min 40 sec
TGT 4:	360° / 11nm	

Putting all of this on your computer and applying the resultant wind to your DR position, you fly for one hour, establishing MPPs with celestial speed lines. You subsequently discover that you have a 30-mile course error! Why? How? Your radar gave you a distorted picture and you did not allow for it. In this case, the actual drift was zero, while your TTW resulted in a drift of 4° left.

Slant Range Error

To see why, we'll have to return to a few basics. Figure 1 shows an aircraft radar mapping a section of the ground. In doing this, the radar electronically changes a

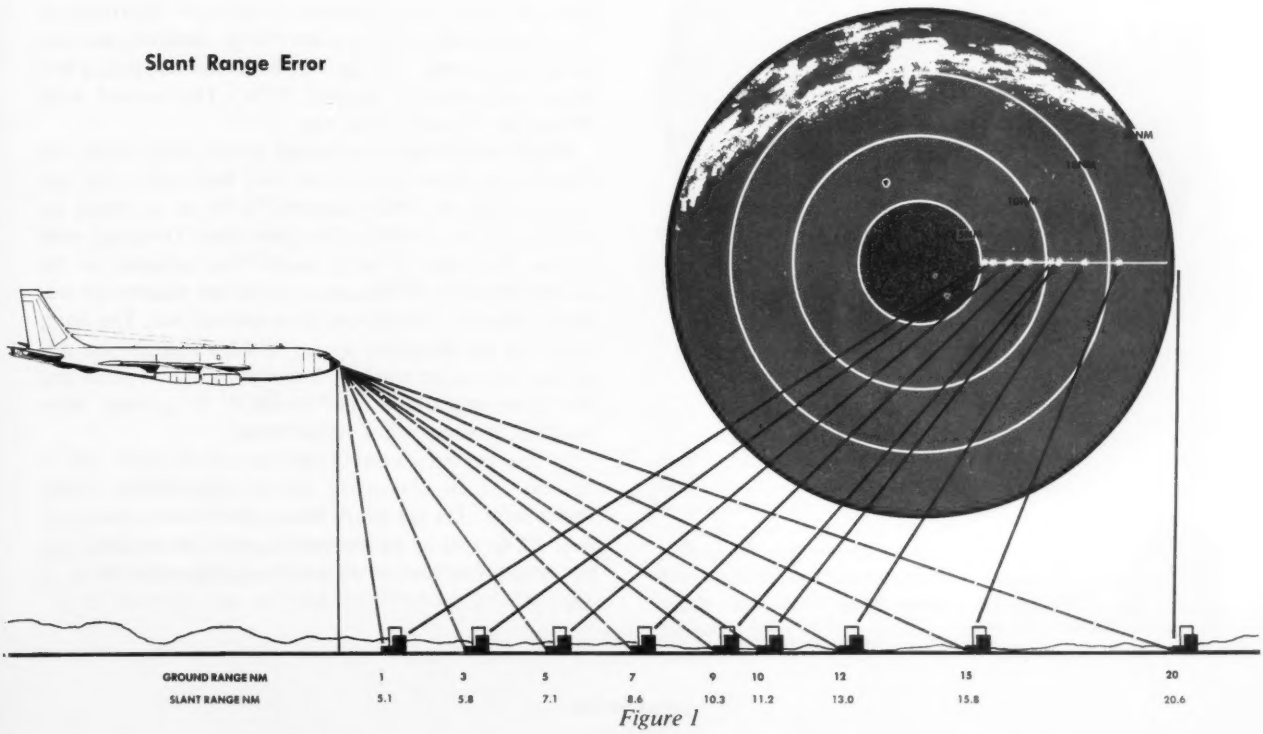
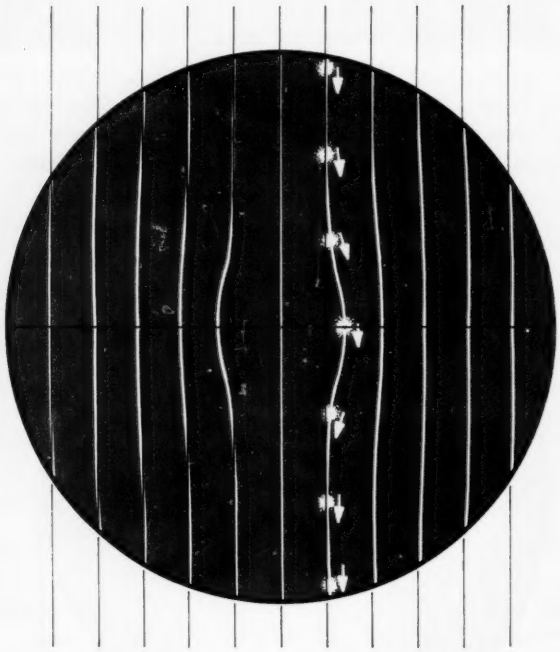


Figure 1

3-dimensional situation into a 2-dimensional picture. You can see there is some difference between the ground and the picture painted by the radar. The darkened area in the center of the radar picture is, of course, the altitude hole.

Now the existence of the altitude hole is no big news. In fact, it's generally treated much like one's own navel; you know it's there, as well as why it's there, but you couldn't care less. However, two things should be stressed concerning the altitude hole: First, what causes it affects all returns on the scope, no matter where they are. Second, these effects can be predicted and avoided.

Notice, in Figure 1, how distances are compressed around the altitude hole. Also notice the larger differences between ground distances and slant range distances. This slant range error is what causes the distortion, and it is most severe for targets close to the scope center. For targets farther from center, the effect is much less. As the aircraft passes over the ground, each radar return tracks across the scope, its path warped by slant range error. And it's this warping that causes the 30nm error in our example.



Lateral Distortion

Figure 2

To help you get an idea of the appearance of this distortion, look at Figure 2. This is a computer solution of a radarscope showing the tracks made by several radar returns. Were the altitude hole "sucked out" as in a B-52 radar set, these tracks would be straight lines. Instead, slant range error causes the lines to be curved. (A 30nm scope is shown to make the effect more visible. It is harder to see on a 50nm scope but the same error exists.)

It should be noted that we are chiefly concerned with *lateral* distortion (or side to side). While slant range error works in all directions from the center of the scope, we need only look at distortion *across* track. Distortion *along* track will be handled later.

Let's consider the TTW again. If you were to plot the information in the example onto Figure 2, the effect of the curve would be obvious. But now consider a different target, at a greater range and closer to the centerline of the scope.

TH = 270° TAS = 400K

The target is tracked as follows:

TGT 1:	262° / 40nm	
TGT 2:	261° / 33nm	Elapsed Time:
TGT 3:	258° / 27nm	2 min 40 sec
TGT 4:	255° / 20nm	

Now we will find a drift angle of approximately ½° right. Again the actual drift is zero. The error here is much smaller. After an hour's flight at 450K groundspeed, the total distance off course would be only 4nm.

The solution to the problem lies in the careful selection of targets. Those that lie within 10° of track give the best results. If your track is unknown but you suspect you are experiencing a large drift angle, use the following procedure. Pick a target close to the heading flash. Obtain a TTW from this and compute an approximate TC. If your drift effect is in fact large, there will be some error in this wind. Use the TC you computed, pick a new target and obtain a second TTW. The second wind should be virtually error free.

When examining slant range error along track, we find the perennial good news and bad news. The bad news is that the error happens to be at its worst for targets close to the aircraft's course line. The good news is that the effect is fairly small. For instance, in the second example the distance run on the radarscope was 20nm, however, the ground distance was not. The range marks on the scope are set up to show straight-line distances; so a target tracking between the 40nm mark and the 20nm mark does not result in 20 ground miles traveled. (Cause—slant range error.)

In the second example, the actual distance run is 20¼nm, which makes the actual groundspeed 456K. This means that for every hour you fly with this error, your ETAs will be 45 seconds in error. Acceptable, yes, but should you wish to do away with this error there is a way.

Figure 3 is a reproduction of a TTW table that appeared in "THE NAVIGATOR" some time ago.* The figures contained therein are for use with the APN-59 radar. Nearly all the error has been removed—not all of it because the table was designed for an altitude above the terrain of 30,000 feet. At different altitudes there will be a small amount of error.

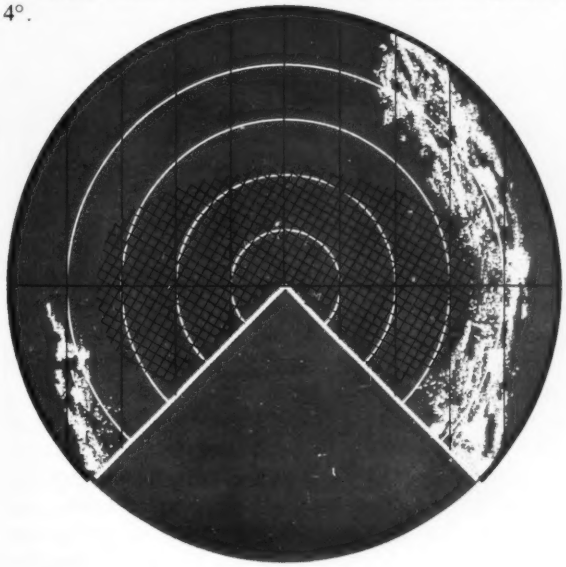
TIME	GS
4'41.4"	260
4'31.0"	270
4'21.3"	280
4'12.3"	290
4'03.9"	300
3'56.0"	310
3'48.6"	320
3'41.7"	330
3'35.2"	340
3'29.0"	350
3'23.2"	360
3'17.7"	370
3'12.5"	380
3'07.6"	390
3'02.9"	400
2'58.4"	410
2'54.2"	420
2'50.1"	430
2'46.3"	440
2'42.6"	450
2'39.0"	460
2'35.7"	470
2'32.4"	480
2'29.3"	490
2'26.3"	500
2'23.5"	510
2'20.7"	520
2'18.0"	530
2'15.5"	540
2'13.0"	550
2'10.6"	560
2'08.4"	570
2'06.1"	580
2'04.0"	590
2'01.9"	600

Target Timing Wind Figured for FL 300

Figure 3

Whatever method you use to obtain a TTW, a good rule to remember is this: Avoid timing targets closer than 20nm from the scope center. When you track targets inside of 20 miles, the information becomes increasingly worthless.

The simplest way of showing just what areas of the scope to avoid using is by diagram. If you look at Figure 4, you'll see such a diagram. The portion of the scope inside the cross hatched area should not be used for TTWs. Distortion there will cause erroneous results as great as 4°.



Area of Greatest Distortion

Figure 4

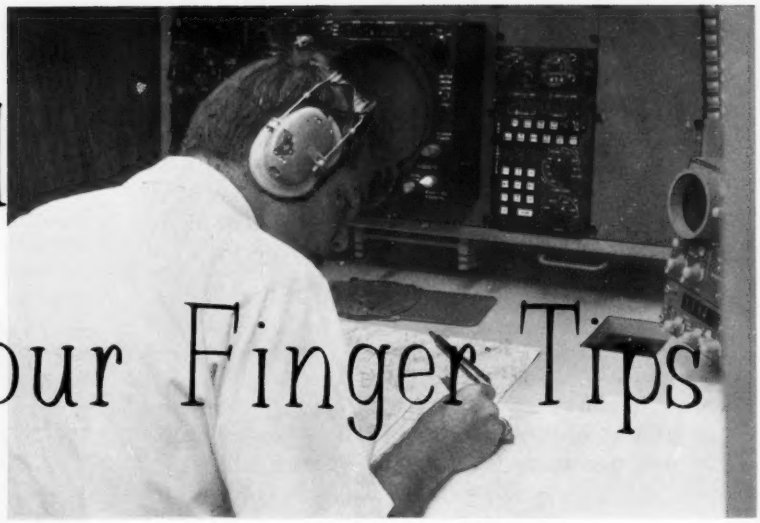
Remember that the APN-59 is something less than a great mapping radar, but it *is* adequate, if properly handled. In the case of TTWs, this means selecting targets close to the aircraft's track and timing them only while they're a reasonable distance from the scope center (at least 20nm). By doing this you'll have eliminated one of the unknowns that plague navigators—and you'll have made your job much easier.

* *Editor's Note: This Figure was taken from an article authored by Captain Daniel O. Pyne and first appeared in "THE NAVIGATOR" in Volume XVII, Number 3-4, Spring-Summer 1970.*

Captain Jim WATTERS

Captain Watters graduated from the Air Force Academy in 1970 with a major in aeronautical engineering. He graduated from UNT in 1971 with an assignment to the KC-135 aircraft, 509 AREFS at Pease AFB. Captain Watters flew the Bullet Shot mission in SEA during the spring of 1972. Since then he upgraded to instructor in 1973 and is now assigned as Squadron Navigator for the 509th.

The World At Your Finger Tips



Mr. Robert E. NICE, Jr.

Navigator training has never had the realism of operational flying. Students seldom had a chance to direct the aircraft; instead they merely kept track of where it had been. This problem was unavoidable since four to twelve students were often being trained simultaneously. The new T45 ground simulator has changed all that. Now each student can direct his own "aircraft" anywhere he wants. He literally has the world at his fingertips.

The T45, with the T-43 and T-37 jet aircraft, is an integral part of the new Undergraduate Navigator Training (UNT) program presently being conducted at Mather. In this new program, all of the academics have been updated to relate to the modern aircraft in the Air Force inventory. The simulator serves as a bridge between the academics of the classroom and the flying environment of the airplane. It permits the student to validate what he has learned in the classroom and practice what he needs to know in the airborne environment.

The training a student receives in the T45 is different from anything navigator students have previously received. At last he is working in a one-navigator, one-aircraft situation, something that was prohibitively expensive until now.

Four students, an instructor and console operator at work.

The UNT student flies 20 missions in the T45. Emphasis areas include Radar/Avionics, High-Low, Celestial, Global, and Grid. The first five missions are devoted to learning to use the APQ-122V(7) radar and other avionics. With the simulator it is possible to selectively malfunction some pieces of equipment to force the student to learn others. This capability prevents the student from relying completely on one piece of equipment. Each T45 position has all the avionics of the master student position on the T-43 and is totally independent of the other positions.

Each of the five radar/avionics simulator missions, culminating in a check, will be flown on a different route. During these missions, the student must use all that he learned in the T-37 phase about communication procedures, departures, and approaches. Because the T45 is a complete simulator, the student must make all radio calls during the mission, just as if he was in a two-seat fighter. During most departures, he directs his aircraft, supplying heading and altitude changes as necessary. He normally has his radar, VOR, and TACAN to accomplish this task. The approach also requires the student's active participation; whether he is directing an instrument approach or an ARA.

After the student's radar/avionics check, he flies two high-low missions. The first of these, a part-task mission, is designed to familiarize the student with the low-level radar environment. The second high-low is a complete mission in which the student does everything. The missions are usually flown at 360 GS and at constant leg altitudes which provide proper terrain clearance. If a student gets off course or supplies an incorrect altitude, he affects no one but himself and will "crash" if he does not maintain terrain clearance. The T45 provides the student with more time actually directing the aircraft in just one mission than in all his T-43 high-low missions combined.

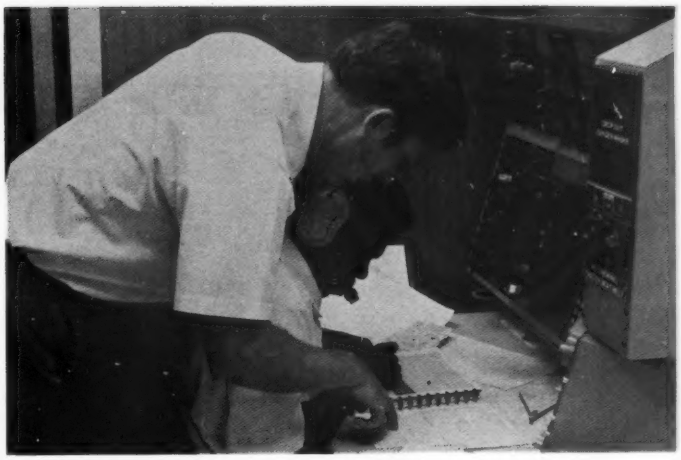
Celestial navigation is the next phase. He has one day and two night missions with celestial only in which to perfect his skills and develop confidence. The AVN-1 automatic sextant substitutes for the periscopic sextant and allows him to shoot the sun during the day and three planets, Polaris, and 41 navigational stars at night.

Global navigation follows celestial and is flown on realistic routes such as Johnston Is to Wake Is and Lajes AB to RAF Upper Heyford. There are five global missions; a Loran part-task mission, three practice missions, and a check. He is able to practice celestial, pressure, and Loran navigation on these routes. Because it is possible to program any one of ten weather patterns on these routes, and the weather is unique to each altitude and location within a pattern, the student encounters different weather conditions each time he flies a mission. Loran carrier wave interference and thunderstorm interference have been programmed into later global missions. Thunderstorms that will show up on a student's radar have also been included on the routes, thus forcing him to take evasive action to avoid them. By carefully selecting routes, it is possible to introduce problems that a student might not encounter until years after graduation. Route selection also varies the quality of the Loran because the ARN-109 Loran is dependent on range from the station and atmospheric conditions between it and the transmitter.

Two grid flights are next. The first of these missions, a warm-up, will take the student from Keflavik to Thule—a more realistic route for flying grid than the central US. The second flight, from Thule to Pt Barrow, goes almost directly over the magnetic north pole. On this route the student sees for himself why grid is so necessary.

The final three simulator flights are devoted to tactical navigation with the radar configured in sector scan, off-set center, and track up mode. Here he sharpens his low level radar skills and is presented with problems that he might actually encounter in a tactical environment. The last of these missions will be his final simulator check.

2Lt Fahie hard at work on a simulated overwater route.



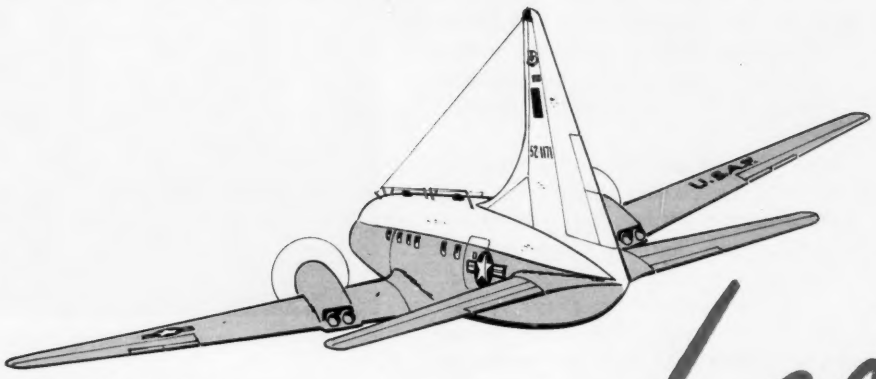
Major Woodrow, instructor navigator, answers a question for 2Lt Fahie.

A normal simulator mission consists of four hours of preparatory academics, a four-hour flight mission, and a one-hour critique. During the four hours of preparation, the student receives a route and weather briefing and completes his flight plan and chart. He then reviews mission requirements with his instructor and discusses any new techniques, equipment, or procedures. The mission itself includes about 30 minutes on the ground prior to take off during which the student must check his equipment, run his checklists, and monitor the taxi. The actual flying time varies, depending on the route and type of approach. Time control for these missions is critical because there is a four-hour limit imposed by simulator availability. Even with this limitation, the instructor can allow a student to make his own mistakes and try to recover, because the T45 allows the instructor to freeze and reposition a student. The last five minutes are devoted to a taxi-in and power down.

Upon completion of the mission, the instructor will critique the student on his performance. To make the critique more effective, the computer stores data on the student's performance and this data is provided to the instructor as a computer printout at the end of the mission. The printout includes the student's actual and computer position, the accuracy of his Navigation Computer updates (to the nearest tenth of a mile), and his average and maximum deviation from course for each leg. It also provides an incontestable record of student performance, lending credibility to the instructor critique.

The 20 missions the student flies in the T45 exposes him to more realistic navigation problems than has ever been possible before. The UNT student of today is trained as a decision maker from the first time he flies the T45. He is required to make his own decisions and live with his own mistakes. The development of this independent decision making capability makes today's UNT graduate an effective navigator much more quickly than yesterday's graduate.

Farewell to a Lady



Major Thomas H. JOUSE
456th Bomb Wing
Beale AFB, California

Captain Mike R. MARTINI
450th Flying Training Squadron
Mather AFB, California

Editor's Note: During the past several years, numerous articles have appeared in this magazine concerning advancements in navigator training programs and equipment. I suspect that while these articles are of tremendous interest to the operating navigators, many of you may find it difficult to relate to these vast changes. Major Jouse and Captain Martini's article should stir the memory of most navigators and relate closely to almost all of us.

When aircraft number 52-1171 landed on Runway 22L at Mather AFB at 1509 hours, 5 March 1975, the Undergraduate Navigator Training program parted company with an old, reliable, and hard working friend. She received no 21 gun salute; no fanfare; nor was she presented awards, citing her for exemplary performance above and beyond the call of duty. Instead she received a dousing by fire hoses, signaling her removal from the training program.

T-29A on early nav training mission. Note the four astrodomes.

Every navigator is familiar with this old, unsophisticated, and noisy bird. Though we have much maligned her, cursed at her, and given her other unmentionable verbal abuses, the T-29 has provided the USAF and many allied countries with the best possible navigator training environment for more than two decades.

The first T-29s arrived at Ellington AFB, Texas, in December 1950 and were fully incorporated into the training program in 1951. After the final training mission, the Tango Two Niner had flown approximately 1,700,000 hours at Mather alone and was the "flying classroom" for more than 35,000 navigators. Though there were some close calls, her record was free of any fatalities; an attribute which endeared her to the hearts of many a crewmember.

Never one to set or even try to set high speed flight, acrobatic, or endurance records; lacking sophisticated avionic equipment; and noisier than the most boisterous mother-in-law, she nonetheless served as an ideal in-flight classroom. With her help, we learned the value of dead reckoning, the usefulness of a driftmeter, how to detect a false sun; why we should not use the universal "honey bucket" during a flight mission; and many other vital navigation procedures, including map reading, radio, radar, celestial, low level, and over-water navigation. A few of us might even vaguely remember learning grid.

Her retirement brings forth many memories. The old (more experienced) navigators might recall their days as students at Harlingen AFB, Texas. We held over Hondo intersection for hours while the weather bird went out to see if we could fly the route that day. There was the in-

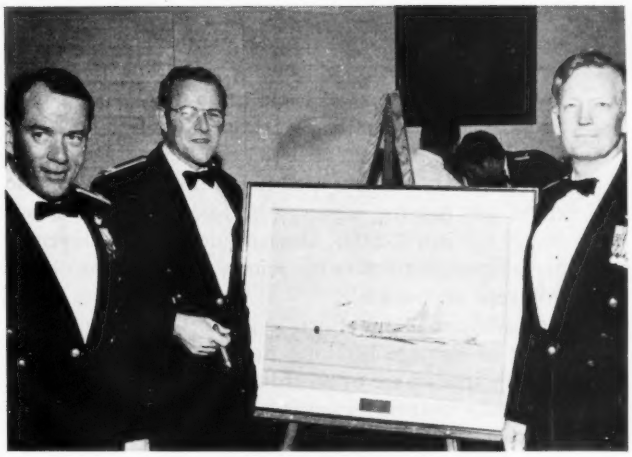
famous route to Sweetwater and the cross-country to Miami and Bermuda, and of course there was 52-1111, "Four Aces: (the Wing Commander's aircraft), the queen of the fleet, complete with its spare landing and nose wheel.

When Harlingen closed, the lady moved on to James Connally AFB, Texas. During that era we assumed the crash landing position from take-off to mission departure and from navigation destination to landing, though we had no idea how we got there. Remember the routes from Waxahatchie intersection to Meridian or Jackson, Mississippi, or from Britton VOR to El Paso or Las Vegas VOR; and the cross-country to California or Florida. You had to carry your "bowling ball" for all celestial missions, and you shot 3-star fixes off of Dubhe, Deneb, and Dallas. The simulated emergency on a night celestial mission began with the loss of lights, three short rings, and a dash towards your position while forgetting to unstrap the astro-harness. Those were the days of the water tank radar trainer with its simulated thunderstorm; the Baylor girls; and Four Aces, not the queen she once was but still a good old girl.

Some of us younger troops might recall our days at Mather AFB. The favorite routes became Overland South and Overwater West, with Overland East reserved only for checkrides. The 3-star fix was now Pollux, Procyon, and Palmdale and the radar fixes were off of Hanford, or was it Corcoran? There was an airborne radar approach to Folsom Boulevard on every mission and numerous unscheduled alter headings to avoid R-2501. During the years at Mather we stopped using the alarm bell for practice emergencies and lost the requirement to carry parachutes on board the aircraft, a testimony to her many hours of safe operation. Four Aces, now tired and weary, was still around, but she spent much more time on the ground.

With the start of the Undergraduate Navigator Training System and the arrival of the sophisticated T-43, we lost the driftmeter, absolute altimeter, radar, night celestial, and overwater requirements on the T-29. She was used only for dead reckoning and integrated fixing

Brig. Gen. Robert W. Bazley prepares to start engines for the last T-29 flight.



Three prominent navs in attendance at DECAL LAST Dining-In, left to right: Col. Robert McCartan, Col. Clark Allison (Ret.), and Col. John Kirk.

procedures. The final flight with Class 76-02 eliminated this responsibility, leaving her with no purpose. She has been replaced by the modern T-43 and the T-37 (another work horse) to fulfill current and future navigator training needs of the Air Force.

Long ago, she was a fancy and very innovative young lady. She was very pilot-oriented, with the cockpit arranged for pilot ease and comfort. She was frequently asked to perform a one-engine landing. This capability saved many of us when she lost an engine 250 miles out on an overwater training mission and McClellan airways was unable to receive our emergency radio calls. She always seemed to have the necessary strength and endurance to get us back home to dear old "Mother AFB" safely. Maintenance crews loved her because of her orange peel cowling, high engine time turnover, short turn-around time, and ceramic coated exhaust.

Through the years she desperately tried to keep up with the times, through modifications, transplants, and uplifts. The first T-29, the T-29A, was a military version of the Convair-liner 240. The T-29B was basically the same as the T-29A but with a cabin heating, ventilating and pressurization system installed. An improved engine was installed in the T-29C and T-29D, but in the T-29D the characteristic astrodomes were removed and the interior arrangement was extensively modified to satisfy navigator-bombardier training requirements.

Despite all the relentless abuse we have given her, the T-29 was a very forgiving lady. In the early '50s, Mather did not have an instrument approach, only an Adcock radio range, a facility that has long since been replaced by several generations of more sophisticated approach aids. Navigator training was conducted mainly under visual flight conditions and little flying was done during the winter because of fog. One pilot, who was not very proficient in shooting radio range approaches, cut across

the American River in marginal weather, missed seeing the electrical towers on each side of the river, and brought home 30 feet of cable belonging to the city of Sacramento. His controls were damaged, and he had to land hot (approximately 160K) but the old girl did get him home. Other pilots used to have contests to see who could get her the highest (the unofficial record was 30,000 feet in a T-29D). These incidents never prevented her from accomplishing her primary mission. The old gal just kept on truckin'.

In addition to our efforts to give her a nervous breakdown or damage her vital parts, we also scarred her smooth appearance by recording numerous "significant" bits of historic information and contemporary comments on her windows, overhead panels, tables, equipment, and her posterior near the convenient crew accomodations. Though some commanders went to her aid by ordering a halt to the writing; and maintenance personnel periodically reapplied her make-up; the incisions continued to appear on nearly every one of her accessible parts. Here is some of the printable and less abusive graffiti that mysteriously appeared:

"Hide this aircraft in the hangar tonight; tomorrow is trash pick-up day."

"Fly Decal Airlines, the proud bird with the bent tail. More super Convair 240s to Peach Springs, Needles, and Points West than any other airline."

"Decal control has been renamed the crisis intervention center."

"Would you believe this panel holds on the wing? Well how about the tail; would you believe the window?"

"Happiness is having read all the graffiti on every T-29...ACCOMPLISHMENT is understanding the significance of it."

Her life was filled with many humorous incidents, and, undoubtedly many of us still remember sharing with her these moments of levity. Take the night celestial mission that took off at 2300 hours. The plane was about the only aircraft in the Northwest United States. With nothing better to do, Center asked if the pilots were going to sleep. "Of course," replied the pilots. Center asked how long they were planning to sleep. "Forty-five minutes," was the reply. Precisely 45 minutes later an alarm clock rang loudly over Center frequency. Another time, the crew of a T-29 found themselves wandering off course due to a handful of disorienting factors (i.e. student navigators). The crew wasn't placing the aircraft in any danger, for the area wasn't used by anyone else at that time of night. The alert traffic controller, however, asked if they wanted a new clearance. Suspecting that they were in trouble for being so far off course, the crew requested a new clearance. The controller then assigned them a WAOWPOUS (pronounced WOW-PUS) clearance. When the crew asked what a WAOWPOUS was, the controller replied, "You are cleared to wander aimlessly over the western portion of the United States."

Four generations of navs on board the last student sortie. 2nd Lt Gary Groce, 1st Lt Dan Turney, Capt. William Ferguson, and Major Thomas Jouse.

Despite all her valiant efforts to keep up with the times, her many modifications, her low maintenance time, and all the written expressions of endearment by her many crewmembers, she had to retire. She was too old, slow, and poorly equipped to meet our rapidly changing training requirements. She was able to weather all the abuse and provide many years of dedicated service, but age catches up with everyone, even the grand old lady.

In recognition of her many years of fidelity, some of her former crewmen, maintenance troops, and acquaintences took part in a nostalgic "Decal Last" Dining-In, held at Mather on 1 March 1975. This final salute to the ageless old gal was joined by many VIPs. The list is too lengthy to mention all who attended, but among the prominent guests were: Major General Charles G. Cleveland, former Wing Commander and guest speaker; Brigadier General Robert W. Bazley, then current Wing Commander; Colonel James R. Burgess (Ret), the first Deputy Commander for Navigator Training; Colonel Clark H. Allison (Ret), former Vice Commander; Colonel Robert O. Mc Cartan, then current Deputy Commander for Navigator Training; Lieutenant Colonel Robert Evans, former pilot in T-29 A, B, C and D models; and Robert Bartley from Sacramento Approach Control. These men, who spent many hours with the old lady flying, navigating, directing, and maintaining her, gave the T-29 an evening which we will never forget. She was toasted, awarded, cajoled, cussed, and ridiculed for the last time. All her best kept secrets, eccentricities, and close-calls were mentioned.

At one time there was a total of 132 T-29s at Mather. Now there is only one, serving as a lasting monument to this old lady's outstanding and faithful years of service.

The final flight of a Mather T-29 (number 52-1170) piloted by General Bazley, took off on 14 March 1975 and safely landed at its final resting place, Davis-Monthan AFB, Arizona. All her sisters have either been given to other commands, other countries, or "mothballed" at Davis-Monthan.

She will rest alongside other famous and dedicated aircraft. She will roast during the day and freeze during the night. Her paint will peel, her metal will gradually rust, she will leak her last drop of black blood, and will no longer smell like a gas station.

From outward appearance one might think she is decaying, becoming a lifeless hunk of metal, devoid of personality, character, or history. All these thoughts disappear as one nears her, for the thousands of radio calls, the footsteps of student navigators running to her rear service door, and the grunts of maintenance men are echoing throughout her walls. She sits quietly remembering all who ever placed a foot in her; all who laughed or cried inside her frame; and all who ridiculed or toasted her. She rests secure in her thought, "I took the best possible care of them all."

Among the many awards presented in her behalf at the farewell Dining-In was a poem. It was written by maintenance personnel who, for so many years, kept the old lady flying, and knew her as well as those who flew her. Entitled "A Farewell to a Grand Old Airman," and read by its author, Technical Sergeant Artis L. Allen, it expresses the various feelings we all have toward this grand old lady. It serves well as a final tribute to the T- 29.

Major Thomas H. JOUSE

Major Jouse is from Chicago, Illinois. He is a 1959 Aviation Cadet and 1960 NBT graduate. He has spent most of his career in PACAF (B-57B and EC-47) and ATC. Prior to his present assignment to the 456 BMW, Beale AFB, he was the Operations Officer of the 450 FTS at Mather. Major Jouse Received his B.A. from the U. of Nebraska and M.A. from Golden Gate University.

Captain Mike R. MARTINI

Captain Martini entered the Air Forve via ROTC in 1970. He completed UNT in April 1971 and then attended NBT. His first operational assignment was to the 456 BMW at Beale AFB in B-52Gs. On his second SEA tour, Captain Martini was shot down and captured on 20 Dec 72. Three months later, 29 Mar 73, he was repatriated. He has been an instructor at Mather from September 1973 to the present.

You're gone, but not forgotten
by the men who loved you so well,
we laughed when you were flyable,
but when you were broke, we caught hell.
Putting you back together again
was really one hell of a job,
when Supply couldn't give us parts,
we found one of your mates to rob.
And after we thought we had you fixed,
you felt proud of yourself,
then the crew would arrive
and find something else.
And some of the stuff they found
was neither here nor there;
you took them out and brought them back
on a wing, sometimes a prayer.
But after you were airborne
your biggest problem arose;
some of those guys
couldn't even put sextants in the hole.
If I could remove your cockpit panel
and publish every witty line,
some of us might be embarrassed
and others might end up doing time.
Since your arrival here
many mechanics have come and gone,
but you stuck it out in grand fashion
so please call Mather home.
If I had to mention any one ship
and single it out by name
that is the most remembered,
Four Aces would be the plane.
I could name hundreds of men
who stood by your wing
and nursed you back to good health
so you could do your thing.
And you heard us rave and cuss,
you heard us laugh and cry,
but believe me, old soldier,
we hate to say goodbye.
And now we have the jets,
with their equipment tuned so fine,
you've been a right-on bird
but you out-lived your time.
And after being with you so long
with all your silver engines burning,
it looks sorta strange
when there's no prop turning.
6000,000 accident-free
hours you have flown
that record is the most incredible
that I have ever known.
Now you are going to retire
after two decades of giving your best,
take it slow, friend,
you really earned a rest.
We're putting you out to pasture
now that your job is done,
you can sit and remember the old times
in the warm Arizona sun.
Now that I'm about to finish
I would just like to say
that if you are ever recalled,
I hope you come my way.

Instructor Duty - Mather Style

Captain Daniel A. YETT, Jr.
452nd Flying Training Squadron
Mather AFB, California

All navigators in the Air Force today began their flying careers as students. Depending on how long ago you earned your wings, you probably remember well what it was like to be a student navigator. Not many of you have seen the other side of navigator training—the role of the navigator instructor at Mather.

This article gives an insight into the job of the ATC instructor navigator. At the same time, for those of you who are Mather graduates, it provides an idea of the many changes that have occurred since you received your wings.

First of all, it is no longer the 3535th Navigator Training Wing; it is the 323d Flying Training Wing. In addition to redesignation, it has also been reorganized. The Wing structure now conforms to the standard Air Force Wing/Base organization. As a result, the Deputy Commander for Navigator Training functions have been combined with the Deputy Commander for Operations (DO) functions. Recent changes in Title 10 of the US Code have made it possible for the DO's position to be occupied by a navigator, thus allowing the Wing to conform to standard Air Force organization, and still effectively deal with the peculiarities of its mission. Both the pilot and navigator training squadrons are under the control of the DO. They, too, have been redesignated:

PRESENT	FORMER	MISSION
449 FTS	3536 NBT	NBT
450 FTS	3538 NTS	UNT
451 FTS	3539 NTS	UNT
452 FTS	3540 NTS	UNT
453 FTS	3537 EWT	EWT
454 FTS	3542 Ops Sq	T-43 Pilots
455 FTS	3542 Ops Sq	T-37 Pilots

Prior to arrival at Mather a new instructor will have been assigned to a UNT, NBT, or EWT squadron, as appropriate. After in-processing, he will enter a class at Instructor Training School (ITS). ITS lasts about 13 weeks. The first three weeks are devoted to initial qualification (60-1) training in the T-43. UNT instructors need training on all systems since they will be teaching and using all the equipment with students. NBT and EWT instructors need only learn the equipment they will use in maintaining their own proficiency. After completing an initial qualification checkride, the student instructor begins the Academic Instructor Course. This is essentially the same course that is taught at the Air University and lasts about three and a half weeks. Some of the subjects covered are: Psychology of Learning, Methods and Techniques of Instruction, Instructional Systems Development, Oral Communication, and Evaluation and Measurement. There are also practice teaching blocks which include two presentations given to a class of navigator students. This gives the budding instructor actual platform teaching experience.

The flying portion of instructor training lasts about five weeks. The advanced schools have gone to a no-fly program, so those destined for NBT or EWT do not receive this phase of instruction. They receive Electronic Warfare simulator or Nav Bomb trainer instruction. Meanwhile, the UNT student instructor flys on a regular student training mission. The various types of flight missions are: Dead Reckoning, Radar, Low Level, Day Celestial, Night Celestial, Global (over water), Grid, and Tactical Navigation (advanced low level). A fully qualified instructor is along to observe and to critique the student instructor on his performance. After seven practice missions, it's time for another checkride; this time it's called an initial instructor qualification (60-2 check).

It also provides the neophyte instructor with T45 simulator upgrading. This training consists of practice missions followed by certification as a console operator.

Upon completion of ITS, a new man is qualified to navigate and instruct in the T-43, teach in a classroom, and instruct in the Navigation Procedures Lab (old N3). At this point the instructor begins additional training conducted by his respective unit. This is called follow-on training (FOT).

FOT consists of observing an experienced instructor teach all the blocks in a given academic specialty. Academic specialties include: Airmanship/Advanced Airmanship; Navigation Procedures; Navigation

Systems/Aircraft Systems (T-43); Day Celestial/Night Celestial; Low Level/Tactical Navigation; and Gyro Steering (Grid)/Global (over water). Once the instructor has completed FOT, he is qualified to perform as an academic instructor, but only in one specialty. At this point he becomes a full fledged, honest-to-goodness, qualified IN.

At the beginning of this article, I alluded to the many changes here at Mather. I have already mentioned some of them such as the T-43 and the T45. Another big change is the introduction of the T-37 to Navigation Training. The navigator instructors don't get involved directly in the flying aspect of this training, although they do teach two-thirds of the academics. We've turned some of our pilots into IPs and academic instructors, a role they are very enthusiastic about. The student gets five missions in the T-37. These missions introduce the student to standard instrument departures, approaches, radio communications, mental dead reckoning, map reading, and unusual attitudes. Another change you've probably already heard about is the departure of the T-29. There's only one left, and it constitutes the entire inventory of Mather's aircraft museum.

If you have been away from Mather for a while you may not know about the Learning Center. This is a facility which allows each student to learn at his own pace. The student sits in a booth with his own slide projector, movie projector, and tapedeck; follows instructions given in the audio-visual presentation; and solves problems or completes other tasks as directed. If he has trouble with any part of the program, he calls for assistance from the instructors who are present.

Something else that's new, or at least changed, is the Nav Procedures Lab (NPL). This is the old N3 trainer. It's been changed so that the student now has a TV monitor on which he gets all basic flight instrument information as well as Doppler, Tacan, and VOR information on a BDHI.

When an instructor is not teaching primary academics to a class, his time is occupied in the simulator, Learning Center, NPL, or by flying. He may also be scheduled to perform ratio duties. A ratio is a sort of helper or aide to the primary instructor. A given block of instruction such as a ground mission may require as many as four instructors to be present in the classroom. This way, the student can receive more personalized instruction on tasks requiring individual accomplishment. There are other duties. Each instructor may be assigned one or more of the additional duties common to all Air Force units. In addition, there are also student records to be maintained, extra help sessions for students who are having trouble with their training, and student check rides to be graded.

A typical instructor's weekly schedule varies depending upon whether or not he is teaching his academic specialty. If he is, his schedule for the week will involve mostly classroom instruction. He may fly once during that week. If he is not teaching his academic specialty, he can expect to fly an average of three days a week. The remaining days would be spent in the simulator, NPL, Learning Center, etc. A flight mission generally involves a nine or ten hour work day. Although a normal work day is from 0800-1700, student training runs from 0600-2400. Thus an instructor can expect to teach academics, ratio, or perform other duties sometime during this period.

Flying time in this assignment has decreased somewhat from the T-29 days. Depending on how often an instructor teaches primary academics, he can expect to get about 350-500 hours of flying time a year.

A navigator may not spend his tour at Mather as a line instructor. He may move up to a supervisory position within his squadron. There are 10 to 15 of these positions in each squadron (depending on the number of students in training). Or he may move into a staff position in the Wing, where there are approximately 86 navigator staff positions. These positions vary greatly. Some include scheduling, curriculum development, and training evaluation. That big simulator doesn't run itself, either. Of course, each man first has to gain practical experience as a line instructor. Not everyone moves into a staff position, but the opportunities are there for those who are capable and desire career broadening.

If you are interested in an assignment to Mather as an instructor, consult AFM 36-20. Basically the requirements are: four years retainability, rank of Major or below, and demonstrated instructor ability or potential. For those who enjoy teaching or working with people, this assignment can provide great personal satisfaction as well as career rewards.

Captain Daniel A. YETT, Jr.

Captain Yett graduated from Kent State University in 1968. He received his commission via ROTC. He graduated from UNT in 1970 with a subsequent assignment of C-130Es to Forbes AFB. From 1971-1972, he was assigned to C-130 ABCCC aircraft at Udorn AB, Thailand. He arrived at Mather in March 1972. Captain Yett instructs navigation procedures in the 452 FTS. He has a DFC and an AM with 1 OLC.

☆ US GOVERNMENT PRINTING OFFICE: 1975—690-090/1